BORON HIGH ENERGY FUELS

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WEDNESDAY, AUGUST 26, 1959

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met, pursuant to call, at 10:15 a.m., Hon. Overton Brooks, chairman of the committee, presiding.

The CHAIRMAN. I think we are fortunate to have such an excellent attendance of the full committee here this morning.

This really is an important subject. I am glad that there are so many of us here.

I have a very short statement indicating the purpose of this hearing which I will read.

The Science and Astronautics Committee is holding hearings today on the nature and effect of the decisions of the Navy and the Air Force to discontinue efforts to open the 5-ton-per-day boron high energy fuel plants recently completed by the Callery Chemical Co., at Muskogee, Okla., and the Olin Mathieson Chemical Corp., at Model City, N.Y. The committee is interested in determining why it took the services 5 years and over $200 million to determine that they had no requirement for the fuel. The committee would like to know the plans that the services have for the facilities, the services' future plans for research in boron fuels, and NASA's interest in boron fuels and the recently completed production facilities.

In addition to the Government witnesses, the committee will hear from the two companies concerned with the production facilities and receive their views on possible uses of these new fuel plants.

Generally speaking, that is the purpose of the hearing.

This morning as witnesses we have Rear Adm. R. E. Dixon, Chief of the Bureau of Aeronautics from the Navy. We have the Honorable Joseph Charyk, Assistant Secretary of the Air Force, Research and Development, who is accompanied by Mr. William Weitzen, Deputy Assistant Secretary of the Air Force, Research and Development. From NASA we have Dr. Emerson Conlon, Assistant Director of Aeronautics and Space Research.

In the order they are listed here, Rear Admiral Dixon is our first witness.

Admiral, do we have a prepared statement from you, sir?

Admiral DIXON. Yes, sir, Mr. Chairman.

The CHAIRMAN. We are happy to have you here representing a great branch of the service and you are accompanied now by whom? Will you give that for the record?

Admiral DIXON. By Captain Robie, on my left, of the Bureau of Aeronautics.

Commander Koch, on my right, for the Bureau of Aeronautics and also Captain Kane of the Bureau of Aeronautics.

The CHAIRMAN. Will you proceed with your statement then, sir.

STATEMENT OF REAR ADM. R. E. DIXON, CHIEF; ACCOMPANIED BY CAPT. F. A. ROBIE, CAPT. R. A. KANE, AND COMDR. R. H. KOCH, BUREAU OF AERONAUTICS, U.S. NAVY

Admiral DIXON. Project ZIP was initiated in 1952 to develop and produce a fuel for Naval aircraft engine application with a substantially higher heating value than existing fuels and to develop means for use of these fuels.

Studies had shown that by increasing the heating value of the fuel, substantial increases in aircraft range could be achieved, or if the range requirement were held constant a comparable reduction in aircraft size could be realized. While this concept of increased heating value of fuels was considered as early as the 1930's, it was in the late 1940's that the details were established for range increases in the ramjet engine by the use of high energy fuels.

In 1951 and 1952, the Bureau of Aeronautics gave consideration to the use of higher heating value fuels in the turbojet engine. The most promising avenue to high energy fuel appeared to lie with the compounds containing boron and hydrogen.

In 1952, parallel research contracts were let with the Callery Chemical Co. and the Olin Mathieson Chemical Corp. to investigate the borohydrides, their production and use.

Also in 1952, the Joint Working Group on Special Fuels was set up under the Assistant Secretary of Defense, Research and Development, to monitor the high fuel program.

Project ZIP, from its inception in 1952 until 1956 was funded primarily by the Navy. In 1956, the Air Force began to sponsor the research and development and subsequent fuel production at the Olin Mathieson Chemical Corp. while the Navy continued the support of project ZIP with the Callery Chemical Co.

During the period of 1952 to 1955, the fuel characteristics were fairly well determined, and it became apparent that the use of this fuel would require extensive engine development and hence consideration was given to the production of fuel in quantities large enough to support this engine development.

Project ZIP was considered by a panel of the Killian Committee, the Technological Capabilities Panel of the Science Advisory Committee. The Committee recommended in 1955 that two 5-ton day fuel production plants be designed and constructed immediately.

In January 1956, the Joint Working Group on Special Fuels also recommended the construction of two 5-ton day plants and approved the design of these plants.

In May 1956, the Secretary of Defense approved the construction of the two plants and directed the Navy and Air Force to proceed with negotiations for construction.

In June 1956, the Navy signed a contract with Callery Chemical Co. for the construction of a 5-ton day plant at Muskogee, Okla., for an estimated cost of $38 million.

Project ZIP was reviewed by a board convened by the Chief of Naval Operations in March 1957. The board, under the chairmanship of Capt. J. P. Rembert, USN, concluded project ZIP to be a research and development program to prove the feasibility and practicability of a ZIP burning turbojet, ramjet, and afterburner. The board also recommended the continued construction of the Muskogee 5-ton day plant.

In late 1957 and early 1958, studies based on preliminary tests conducted by the National Advisory Committee for Aeronautics and aircraft engine manufacturers amplified the magnitude of the problems to be overcome in order to use this fuel in all jet aircraft. While it was considered feasible to use this fuel in ramjets and afterburners, the problems associated with use in the basic turbine were quite difficult, and it became evident that in order to use this fuel in the basic engine, the engine would be required to operate at the very high temperatures associated with high power output and supersonic cruise aircraft.

At lower engine temperatures, the products of combustion rapidly foul turbine blades and other engine parts. It is also apparent that in order to realize the full potential of ZIP fuel, the fuel must be used in the main engine of an aircraft throughout the entire flight.

In 1958, emphasis in the Navy shifted from high performance attack and fighter aircraft to slower aircraft that were to perform as platforms for high performance missiles. This shift of performance to the missiles resulted in a reorientation of Project ZIP toward applications for missile propulsion. This reorientation was requested by the Chief of the Bureau of Aeronautics and approved by the Chief of Naval Operations in November 1958. With this shift of emphasis, the Navy requirement for high energy fuel was reduced to approximately 25 percent of the Muskogee plant production.

Based on informal talks with the Air Force, the Navy invited the Air Force to participate in the Muskogee production in December 1958. The Air Force declined, but invited further discussion. Again the Air Force was invited to participate and again declined in April 1959.

In June of 1959, the Chief of the Bureau of Aeronautics recommended termination of the Muskogee production contract and requested the concurrence of the Chief of Naval Operations. The Chief of the Bureau of Aeronautics also recommended that the concurrence of the Secretary of Defense be obtained prior to terminating due to the scope of the program and the national defense aspects involved.

In June of 1959, the Director of Defense Research and Engineering initiated a comparative study by A. D. Little, Inc., of the two 5-ton day high energy fuel plants that were to begin production in August 1959. This study was to determine which plant would be the most economical and technically sound to operate if only one of the two plants were to operate.

When the Air Force requirements for a 5-ton-day plant were recently removed, the Navy had no alternative but to terminate, since Navy requirements had previously been drastically reduced.

Project ZIP, while technically successful in the production of a fuel of higher heating value, has been rendered marginal by rapid advances

in the missile field and by the reduction of emphasis on high performance piloted aircraft. Other lesser considerations involved in the reorientation of the ZIP program include the high cost of fuel, handling problems due to the toxicity of the fuel, and logistic problems associated with fleet usage.

The future of boron-based fuels for Navy applications now rests with continued developments of compounds and systems revealed only recently; these being in the field of liquid monopropellants, additives for solid propellants, and other boron compounds. These fields are being investigated at a level of effort considered appropriate to the progress made to date.

At present, the Navy-owned Muskogee plant is in a standby status, capable of restartup within 6 to 9 months. This status is being maintained until the Joint Working Group on Special Fuels meets in September to review the Department of Defense sponsored A. D. Little study. At that time the future scope of the high-energy fuel program will be determined.

Appended to my statement, Mr. Chairman, is a listing of the moneys put into this program. I will read them if you so desire, sir.

The CHAIRMAN. Yes, if you will. They are not long.

Admiral DIXON. Total money put into Project ZIP is $123 million. This is broken down as follows:

Research and development (includes ramjet engine)	$53,000,000
Muskogee high-energy fuel plant construction	35,000,000
Muskogee high-energy fuel plant startup costs	9,000,000
Other fuel production	7,000,000
(This includes approximately 90,000 pounds of HEF–2 from the Olin Mathieson Chemical Corp. (OMCC) 0.8 ton-day plant, 27,000 pounds of HiCal–3 from the Callery Chemical Co. (CCC) 300-pound-day plant and costs of sodium borohydride used as a raw material at the OMCC 0.8 ton-day plant.)	
Fuel production facilities (other than Muskogee)	3,000,000
(This includes the Navy portion of the OMCC 0.8 ton-day HEF–2 plant and the sodium borohydride facility operated by Metal Hydrides.)	
Research and development facilities and unexpended balance of obligated funds	16,000,000
(This includes equipment and facilities in support of research and development contracts at CCC and OMCC, unexpended balance of funds under the Muskogee construction and production contracts.)	

The CHAIRMAN. Thank you, Admiral. We appreciate your statement.

That plant at Muskogee was completed when, Admiral?

Admiral DIXON. It is approximately 99 percent complete now, Mr. Chairman, and it would have started production in August, this month, had we not terminated.

The CHAIRMAN. Now, you terminated it on what date?

Admiral DIXON. The dispatch was sent 10 days ago and we are in the process of negotiating the degree of closure. We are putting them on a partial maintenance status and that is being negotiated at the moment with the company.

The CHAIRMAN. So actually your termination and the completion of the plant was just about synonymous?

Admiral DIXON. Practically; yes, sir.

The CHAIRMAN. It came at the same time.

Now, I have followed your statement with a great deal of interest.

I see you have spent $123 million on the project to date.

The reason for your changing is the reduced emphasis on high speed aircraft. I think that is the No. 1 point that you made.

Admiral DIXON. As far as the Navy is concerned that is correct, Mr. Chairman.

The CHAIRMAN. Do you or your department feel that the development of the missile has taken emphasis off of the high speed aircraft?

Admiral DIXON. Very definitely, sir.

The CHAIRMAN. Therefore, as missile development proceeds, the emphasis will come progressively off of the high speed aircraft?

Admiral DIXON. That is correct, sir. I think it will be gradual, but——

The CHAIRMAN. The more progress in the missile program, the more you would expect that conclusion with regard to aircraft?

Admiral DIXON. Yes, sir. I refer to the air launched as well as ground launched.

The CHAIRMAN. What you are saying to the committee is that the missile program as it develops is taking over the need for the production of high speed aircraft. Is that right?

Admiral DIXON. May I phrase it this way: Within the Navy, our requirements, we feel, will be fulfilled more and more by the missile—with the performance in the missile, rather, than with the performance in the airplane. We will still need aircraft but our desires are to put the performance in the missile as much as possible.

The CHAIRMAN. There is an evolution of the development of the missile which means that ultimately a large portion of your mission will be taken over by unmanned weapons, rather than by manned aircraft?

Admiral DIXON. Mr. Chairman, in the context in which I use this analogy here, I am referring to aircraft and missile combination.

Either for defense or for attack. We feel for both purposes as regards the aircraft, for our purposes the mission can be accomplished better by utilizing the aircraft as a base and putting the performance in the missile rather than in the aircraft, itself.

The CHAIRMAN. Now, what about this toxicity of the fuel? I had heard something about that. When did you find it had a toxicity content?

Admiral DIXON. We knew that from the beginning, Mr. Chairman. We did not know the full implications of it but we did know that this fuel was toxic and had to be handled very carefully so that is not a recent discovery.

The CHAIRMAN. And the logistic problems are not new, either?

Admiral DIXON. No, sir; we realized we had some severe problems when we undertook this program but at the time we undertook the program the benefits were so great that we decided it was worthwhile to continue.

Now, Mr. Chairman, I would like to emphasize one point: These two plants that we are really talking about—and the Callery plant, are part of an R. & D. effort.

These plants were not envisaged as producing quantities of fuel for operational use. They would have fitted into that picture later but they were required for the R. & D. endeavor in this field.

If this fuel had gone into production for operational use, a much greater productive capacity would have been required.

The CHAIRMAN. Were these in a sense pilot plants?

Admiral DIXON. The smaller ones were pilot plants but these were plants developed to provide sufficient fuel so that we could proceed with the engine development program which really had many problems in front of it.

The CHAIRMAN. When did you actually arrive at the decision that this plant was not going to be needed?

Admiral DIXON. As I stated in my statement, Mr. Chairman, in 1958 when we decided we would put the performance in the missile, the requirement utilize this high-energy fuel in our turbojet engines evaporated so that reduced our requirement from the Muskogee plant approximately 75 percent because at the time we were still considering the application to ramjets, and so forth.

The CHAIRMAN. So that was in 1958 and then you began to turn to the Air Force to see if the Air Force had any requirement?

Admiral DIXON. That is correct, sir.

The CHAIRMAN. When the Air Force turned you down on that, then it made the plant surplus in a sense?

Admiral DIXON. That is correct.

The CHAIRMAN. When was that?

Admiral DIXON. I believe in response to an inquiry in June 1959, we then requested the Department of Defense to concur in our termination after surveying the Department of Defense to see if there was a requirement for the plant. So, it is quite recent that it was evident there was no requirement for this plant within the Department of Defense, at least for the moment.

The CHAIRMAN. Does that include the large Kansas plant of the Callery Co.?

Admiral DIXON. That is correct, sir.

The CHAIRMAN. Who put the money into that large Kansas plant?

Admiral DIXON. The Callery Chemical Co., sir. That is a wholly owned plant of the Callery Chemical Co.

The CHAIRMAN. The Muskogee, Okla., plant is a U.S. investment?

Admiral DIXON. That is correct.

The CHAIRMAN. That is entirely our investment?

Admiral DIXON. That is correct.

The CHAIRMAN. Do you have any hope for the use of that plant in the immediate future?

Admiral DIXON. Mr. Chairman, we have looked avidly to find a use for this wonderful facility. At the moment we have been unsuccessful. This is a unique process and it is very difficult to adapt it to other requirements in the Department of Defense or commercially, I would say.

The CHAIRMAN. You have a joint working group on special fuels and they are going to report in September?

Admiral DIXON. That is correct, sir.

The CHAIRMAN. Do you have any other report you are looking for?

Admiral DIXON. No, sir; not at the moment.

The CHAIRMAN. That is the only one?

Admiral DIXON. Yes, sir.

The CHAIRMAN. If they find a use for it, then there is a possibility the plant would not be a total loss?

Admiral DIXON. That is correct, sir.

The CHAIRMAN. If they find no use for it, is the plant then a total loss?

Admiral DIXON. Unless we can find other uses for it within the country. If we declare it surplus, we will certainly try to enlist the interest of someone who can use it productively because, then, we obviously would get more money for the plant.

The CHAIRMAN. What effort are you making now to find other uses?

Admiral DIXON. I have my bureau surveying all possible applications of this plant to commercial or other military uses, but so far we have been unsuccessful, Mr. Chairman.

The CHAIRMAN. From what you tell me, it must be a very beautiful plant and certainly is modern. Is there no way to readapt or refashion it?

Admiral DIXON. We are finding it very difficult to do that, Mr. Chairman, to readapt it.

It is a beautiful plant and while it cost a large sum of money, it was economically built, under what we expected it to be built for and I consider it a very excellent facility.

The CHAIRMAN. Does the same thing apply to the large Kansas plant of $7 million?

Admiral DIXON. I am not fully acquainted with that, Mr. Chairman. It is a company-owned plant and I have never visited it.

The CHAIRMAN. How many people are employed at Muskogee?

Admiral DIXON. I think it is approximately 450.

The CHAIRMAN. Had they employed any of them at the time the order went out?

Admiral DIXON. They were in the employ of the company, sir.

The CHAIRMAN. 450 lose their jobs?

Admiral DIXON. With our negotiations going forward at the moment we anticipate some 125, or approximately 125 will be retained to keep the plant in a partial standby status but how long that will continue, I cannot say, Mr. Chairman.

The CHAIRMAN. That would make about 325 who would lose their jobs immediately?

Admiral DIXON. That is correct.

The CHAIRMAN. And the others have a rather precarious future in their employment?

Admiral DIXON. That is correct, sir.

The CHAIRMAN. Mr. Martin, our former Speaker of the House, do you have some questions?

Mr. MARTIN. No; I think he has adequately described the situation.

The CHAIRMAN. Mr. Miller?

Mr. MILLER. Admiral, the Callery plant you say was wholly owned by the Callery Co.?

Admiral DIXON. No, sir.

The Lawrence, Kans., plant is. The Muskogee plant is wholly owned by the Government.

Mr. MILLER. Did the Government subsidize the one in Kansas in any way?

Admiral DIXON. It is a company-built plant, I think, costing about $5 million. It was utilized in connection with our Muskogee plant but, nevertheless, the company put the money into the plant.

Mr. MILLER. Of course, in many of these things, the companies would seek subsidies from the Government because the Government is the sole taker of their product. Although they are listed as private companies, nevertheless the Government owns a part of them.

Is that the case in this plant? Did the Government put up some of this $5 million?

Admiral DIXON. No, sir; we bought the output from the plant. We contracted to do that.

Mr. MILLER. On the basis of our buying the output they speculated and put up the money?

Admiral DIXON. That is correct, sir.

Mr. MILLER. Are they going to come back to us now that we are cutting out the buying of their product? Did we have any contract that we were going to buy it?

Admiral DIXON. May I ask Commander Koch to speak on that, Mr. Chairman. We are getting into a contractual matter here.

Commander KOCH. We have completed the fuel production contract at the Lawrence plant—it was completed in the early part of July 1959. Currently we have no contract for production of fuel at the Lawrence plant. They are doing production engineering work still in support of the Muskogee plant while it is in a standby status, but no fuel production.

Mr. MILLER. Then the Lawrence plant is going to come in and claim damages from the Government because we have changed the need for the use of this fuel? They are going to come in and tell us we owe them a lot of money?

Admiral DIXON. Mr. Miller, my understanding at present is that that is not the case, but I would like to check the record.

Mr. MILLER. We have seen that happen in the past and I wanted to be sure.

I have no further questions.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. You have the funding for the Project ZIP. Your figures do not show the source of the funds. Do you mean they are the funds from both the Air Force and the Navy?

Admiral DIXON. No, sir; these are Navy funds.

Mr. FULTON. Would you add on the funds from the Air Force so that we can see what the funding for the total Project ZIP is; from your figures, it says "Total Project ZIP, $123 million" under the heading "For Project ZIP."

These figures indicate the total amount when, as a matter of fact, it is not.

Admiral DIXON. These are Navy figures only, sir.

Mr. FULTON. Where do we get the Air Force figures?

Admiral DIXON. The Air Force is appearing after the Navy and they will provide it.

Mr. FULTON. So this is only from Navy sources?

Admiral DIXON. That is correct, sir.

Mr. FULTON. What is the total, overall?

Admiral DIXON. I will have to get the Air Force figure.

The CHAIRMAN. It is $243 million, but the Secretary will be here to present the Air Force figures.

Admiral DIXON. I do not have the Air Force figures, sir.

Mr. FULTON. Now, then, it looks to me as if the Navy might have been making the decision to go ahead on this high-energy fuel of the toxic and very high temperature type at the same time the Navy was deciding to do otherwise on the Polaris.

What is the difference in the reason for decision between the Polaris missile under Admiral Raborn and the ZIP fuel for this particular type of plane?

Obviously, the fuel could be used—what is the reason for the difference in decision in this type of fuel from that in the Polaris?

Admiral DIXON. I think Admiral Raborn felt that that fuel was best suited for the missile.

Mr. FULTON. He chose a solid fuel which was easy to handle, that was stable and had low toxicity for handling on board ship. Why was not the same done here?

Admiral DIXON. Also the fuel that he chose was more or less available. This is a developmental project, Mr. Fulton, including engine and fuel development. This was a fuel development project in addition.

Mr. FULTON. Yes, but ahead of time I think most everybody knew that boron hydrides all had high toxicity and required high temperatures for operation and were relatively unstable.

Admiral DIXON. That is correct.

Mr. FULTON. Why wasn't that taken into consideration when we were considering fleet handling?

Admiral DIXON. It was taken into consideration, Mr. Fulton.

I would like to say we are talking about a period 7 years ago when this program had its inception.

Many things have happened in 7 years in technology. Polaris was not even a gleam in anyone's eye at the moment.

Mr. FULTON. Yes, unfortunately, this from the Navy alone would make 123,000 scholarships for research students of $1,000 apiece. It would be a quarter of a million scholarships of $1,000 apiece if you take both what the Air Force and the Navy has spent on it.

What is the reason parallel research contracts were let for this particular product? Why two?

Admiral DIXON. State of the art, sir.

We did not know where we were going or how we would get there.

Mr. FULTON. And you feel either the Callery Chemical Co. or Olin Mathieson Chemical Corp. were insufficient in their research capacities or progress to that date? Is that included, too?

Admiral DIXON. May I ask Captain Robie who was in at the inception of this project to answer that?

Captain ROBIE. The reason we selected Callery Chemical is that they worked in this field some years previous to that and had experience.

Mr. FULTON. When were they picked in relation to the Olin Mathieson Corp.?

Captain ROBIE. They were both picked simultaneously.

Mr. FULTON. Then the question recurs why did you pick two instead of one?

Captain ROBIE. Because of the difficult problems, knowing that the fuel was toxic, it did not have the properties that we desired. We felt

if we were going to get the end result we desired and—remember, this fuel was primarily intended for use initially in the turbojet engine.

Mr. FULTON. It would work for the Navy, only on carriers?

Captain ROBIE. Yes, essentially.

Mr. FULTON. Why was a high toxic fuel chosen by the Navy as against its being chosen by the U.S. Air Force? Why would you go into a high toxic, unstable high temperature fuel for use on carriers when you were doing just the opposite on the Polaris missile, on submarines?

Captain ROBIE. We had intended to engineer around the toxic problems and that is one reason we engaged these two companies to work for us.

Mr. FULTON. In fact, did you think it was insufficient?

Captain ROBIE. Yes, sir; at the time we thought we needed two—Olin Mathieson because of its large industrial capacity, and Callery because of its experience.

Mr. FULTON. Did Olin Mathieson have experience on boron fuels previously?

Captain ROBIE. They had done very little work in that area at the time we employed them.

Mr. FULTON. Why did you choose them?

Captain ROBIE. Well, initially we went out to the big oil companies and the big industrial chemical companies, and Olin Mathieson indicated the most interest of all those we contacted.

Mr. FULTON. How were these contracts negotiated? Were they bid contracts or were they simply given on a basis of your choosing the particular company, and then were they on a cost-plus basis or were they actually on a contract price?

Captain ROBIE. The initial contracts for R. & D. were on a cost-plus-fixed-fee basis. The contractors proposed the areas in which——

Mr. FULTON. You can put that in the record here without going into the details. How much was the fixed figure?

(The information requested is as follows:)

As stated previously, the Bureau contacted several of the large oil and chemical companies and presented the high-energy fuel problem to them; those contacted were:

Monsanto Chemical Co.
Mathieson Chemical Corp.
American Cyanamid Corp.
Minnesota Mining & Manufacturing Co.
Standard Oil of New Jersey
Standard Oil of Indiana
Standard Oil of California

Other companies who had been contacted but could not accept prime contracts because of the urgency of their own industrial business or other Government contracts are:

Texas Oil Co.
Westinghouse Electric Co.
Union Carbide & Chemical Co.
Gulf Oil Co.
Standard Oil Development Co.
E. I. du Pont de Nemours

Olin Mathieson (then Mathieson Chemical Corp.) showed the greatest interest and was, therefore, selected. Because of the magnitude of the problem, it was decided to engage two companies to work on the fuel development, and the Callery Chemical Co. was engaged because of its previous experience; the two-prong attack on the fuel development has been reviewed continuously throughout this program and each time approved as the proper course of action.

The R. & D. contracts have always been cost-plus-fixed-fee negotiated contract, except the initial contract with Olin Mathieson was a cost-without-fee contract; the reason for this was that Olin Mathieson believed that numerous commercial benefits would be derived from the research on the fuels which would adequately compensate them for their effort. The facility contracts were always cost-without-fee negotiated contracts.

Captain ROBIE. The fixed fee averaged about 7 percent on the initial R. & D. contracts.

Mr. FULTON. And how much were the original contracts then in each case?

Captain ROBIE. The initial contracts were approximately $3½ million to Callery and $4,200,000 to Olin Mathieson.

Mr. FULTON. What was your original estimate on the total cost of this research when you were looking into whether to proceed with this program on this fuel? You knew it was going to be a high cost fuel but you must have had some idea of the overall cost that would take you to get the R. & D. program through.

Captain ROBIE. Yes, sir; the initial estimates of the research program were well over $100 million to extend into 1961.

Mr. FULTON. How did they run up into $243 million by 1959?

Captain ROBIE. Bear in mind, Mr. Fulton, the original estimates were basically the R. & D. estimates for research in the fuel. A substantial portion of this $243 million goes into these larger plant costs. For instance, the Navy bill alone is $44 million.

Mr. FULTON. Into what costs?

Captain ROBIE. The facility costs for the larger plants.

Mr. FULTON. So that really you were going ahead on an expansion program within the R. & D. program so that you got more fuel by expanding the size of the plants from what you would call a pilot line.

Captain ROBIE. There were two basic problems. One was to research the fuel and then——

Mr. FULTON. A pilot line would take care of that.

Captain ROBIE. That is right, and then——

Mr. FULTON. Then you made the decision to go beyond a pilot line—I want the reason for that decision?

Captain ROBIE. When we got into the hardware development program, it was necessary to get larger quantities of fuel and that was the reason for these two 5-ton-per-day plants.

Mr. FULTON. Why couldn't you, on a test stand, see whether it would foul turbine blades at lower temperatures or that it would get a coating on the turbine blades at higher temperatures? Why did you have to go into such a department-store production?

Captain ROBIE. Well, Mr. Fulton, we knew that the products of combustion would foul the turbine blades and that was one reason we had to carry on these hardware development programs to see if we could engineer around these difficulties.

Mr. FULTON. Why did you do it with such an extended production of this fuel when you could just use test stands?

Captain ROBIE. These are minimums compared to what we use in our engine development with conventional fuels.

Mr. FULTON. This was certainly an uncertain fuel, was it not?

Captain ROBIE. From the outset, yes, sir, it was.

Mr. FULTON. Can you tell us then what fouling would happen at high temperatures as distinguished from low temperatures?

Captain ROBIE. Well, boric oxide melts at around 1,000° F. and from 1,000° to 3,300° it is in a highly mobile state. It vaporizes at around 3,300° F. If we could operate in the temperature 1,200 to 1,300° F., it would be possible to assimilate the products of combustion in the engine in a more or less conventional manner. Unfortunately, the turbojet engines operate normally in the exhaust temperature of 800 to 1,200° F.

Mr. FULTON. What added speed and strategic availability did you get from this fuel compared to the current fuels? What was the margin you were getting?

Captain ROBIE. The primary benefit from a performance standpoint in this fuel is that you substitute a different heat source which is concentrated in more energy per pound than the conventional fuels.

Mr. FULTON. What added operational capabilities were you getting in performance? I want you to relate the total cost of over $100 million to what you were then going to get in strategic capability.

Captain ROBIE. We would get as high as 40 percent range increase.

Mr. FULTON. What is that?

Explain it.

Captain ROBIE. For instance, if you had an aircraft of, say, a given weight that had a range of 2,000 miles, we could increase that range by 40 percent.

The CHAIRMAN. Let me interrupt you and suggest this thought. Now, it is 10:50 here and we have Assistant Secretary of the Air Force Charyk and Dr. Conlon and we ought to hear them this morning. Then I think there are just a thousand things we can go into and we might have to extend this hearing for some time, but in the meantime let me ask that the members cut their questions short and if we do not cover the field, we will ask the admiral and the captain if they will come back, to go into the details of the matter.

Mr. FULTON. I am through. May I just finish on one question?

The CHAIRMAN. Yes.

Mr. FULTON. I was asked by Mr. Martin if I were prepared and had done my homework, and I have. I asked questions for him as well. I will ask one more question and I am through.

On page 3 of your statement there is the comment:

> In 1958, emphasis in the Navy shifted from high performance attack and fighter aircraft to slower aircraft that would perform as platforms or high performance missiles. This shift of performance to the missiles resulted in a reorientation of Project ZIP toward applications for missile propulsion.

And then it would seem to me that the missile emphasis, from this statement, in the Navy was shifted just about the end of 1958 or the beginning of 1959.

Now, I would like to have that explained to me why the emphasis on missiles is only occurring in the Navy at that particular point. Isn't that late?

Admiral DIXON. Mr. Fulton, we realized from the start that this fuel utilized in missions other than the turbojet engine could give great advantages. For instance, it can be burned in an afterburner, it can be burned in a ramjet.

We had given emphasis to this program for the Regulus II program, which has a J–79 General Electric engine in it for application but Regulus II was terminated and this is a part of this picture that we portray on page 3. Our present programs are in a research stage and they involve, as I state, solid and liquid—solid applications to that field, and so forth, but it is a small research activity which does not require the output of this plant.

The CHAIRMAN. Now at this time I recognize Mr. Teague, who is the chairman of the Subcommittee on Research and Development.

Mr. TEAGUE. Mr. Chairman, I have no questions.

Admiral, it is quite a shock to a lot of us to organize, and work for money for research and development and then find mistakes of $200 million or $300 million going down the drain.

Mr. Chairman, I hope you will go far enough into this so that you will know exactly who is responsible and that something will be done about it.

Maybe from a scientific viewpoint it can be completely justified but from the standpoint of being in Congress and hearing the President last night talk about cutting down on the money going into defense, I just think somebody ought to answer for a mistake like this.

Whoever they are I do not know, but I hope that you will go far enough that we can point out exactly who is responsible for a mistake of this kind. It just does not seem to me possible that they could go build these plants and go this far and not have known it before now.

As you well know, last week over on the floor we argued and fought about $28 million in research and development for the space agency.

Admiral, is anyone at fault enough that they should be punished for this? Civilian or military?

Admiral DIXON. Mr. Teague, I definitely think not. I would like to state——

Mr. TEAGUE. I hope you are right because I think it is quite a shock to the American people to find out we just poured $300 million down the drain.

Admiral DIXON. I would like to state, Mr. Teague, we realized from the inception that this was an enormous undertaking. We requested that the program be reviewed by the best technical brains in the country.

Mr. TEAGUE. You feel like that has been done?

Admiral DIXON. That has been done more than one time. We were told to go ahead, we were backed up in our decisions and unfortunately technology has passed us by.

However, I do not think you can ever expect R. & D.'s every endeavor to turn out an operational weapon.

Mr. TEAGUE. I realize that but for example, last week on the floor when the Appropriations Committee made this cut and said "You can't justify it," of course we can't. But it is difficult to see how you can go this far and not have been able to stop before this.

Admiral DIXON. The unfortunate thing is that from the start this research and development endeavor was expensive even before we could find out really what we had or whether we would have it in time or not. We faced that fact from the start. We did nothing—we did not go into production of this fuel for an operational purpose. We knew we were a long ways from it.

Mr. TEAGUE. Certainly it looks like you would know before you built two plants. It looks like you would build one, first.

Admiral DIXON. I would say you are right.

The CHAIRMAN. Will the gentleman yield?

Mr. TEAGUE. I will be glad to yield.

The CHAIRMAN. I think, what the gentleman has to say is correct, but here in the chart for research and development is $53 million but the expenditures are $123 million which indicates the difference is operational.

It would seem, before operational capabilities are established, that you would know about your research and development.

Admiral DIXON. The difference, Mr. Chairman, are facilities—in order to get the fuel.

The CHAIRMAN. That is operation.

Admiral DIXON. It is operational in that we were trying to get fuel for a research and development program; yes, sir.

Mr. TEAGUE. Mr. Chairman, there are a lot of us on this committee who support you people down the line on defense. You heard the President last night before he left. What he said about it but it is a shock and inconceivable to me that you would go this far and build two plants before somebody knew it was wrong, if it was wrong.

Mr. Chairman, that is all.

The CHAIRMAN. Are there any questions here?

Mr. CHENOWETH. No questions.

The CHAIRMAN. Mr. Anfuso?

Mr. ANFUSO. Admiral, what I am going to say is not by way of criticism because we all admire the efforts which the Navy is making in research.

At the time that you commenced this program, which was about 5 or 6 years ago.

Admiral DIXON. Seven years ago.

Mr. ANFUSO. 1952?

Admiral DIXON. 1951–52, in there; yes, sir.

Mr. ANFUSO. The missile program was on the way. I mean we had it at least in blueprint and in research. We had begun the missile program. Right?

Admiral DIXON. Yes, sir.

Mr. ANFUSO. Of course it was anticipated or, rather, it was hoped that through the missile program we would achieve results and they were taken into consideration by you; is that correct?

Admiral DIXON. That is correct.

Some of the things in the missile program are things we had hoped for 7 years ago, and possibly some we did not hope for; yes, sir.

Mr. ANFUSO. So, with that background and information, you understood this other program which I am sure had a use separate and apart from the missile program; right?

Admiral DIXON. Very definitely.

Mr. ANFUSO. You felt at that time, even though the missile program went as far as it has gone, that there was some definite use for this other program, for the development of these high fuels; right?

Admiral DIXON. Definitely, sir. Very definitely.

Mr. ANFUSO. Why is that need now gone? Is it anticipated we are not going to do anything about developing speedy aircraft in the future?

Admiral DIXON. Not entirely, but I think we have reaped the results of technological advances.

Our normal turbojet engines are doing better on existing fuels than we had anticipated then. We have used aerodynamics so that we have—one of the big problems at the time you were talking about is the fact that our aircraft were continuing to increase in size. This was a way to reduce them. We could use less fuel and therefore smaller airplanes.

But we have reaped other benefits, and I say our desire now is to let the missile do most of the work for the airplane, and that is definitely a big factor in our change of mind in this.

Mr. ANFUSO. This decision to discontinue these high-energy fuels, was that a political decision?

Admiral DIXON. Would you repeat that, sir?

Mr. ANFUSO. This decision to terminate these high-energy fuels, was that a political decision made by someone in the administration?

Admiral DIXON. Definitely not; definitely not.

Mr. ANFUSO. Where was it made and who made the decision?

Admiral DIXON. I made the recommendation for the Naval Aeronautical Establishment to the Secretary of Defense and he is to make the final decision, sir.

Mr. ANFUSO. It originated from you?

Admiral DIXON. As far as the Navy goes, yes, sir.

Mr. ANFUSO. I yield the floor.

Mr. TEAGUE. Admiral, is there a difference in personalities? Where were you when the decision was made to start the thing?

Admiral DIXON. I was at sea, sir.

Mr. TEAGUE. I was in the service about 6 years and I saw a lot of decisions made and where a new man comes in, he starts changing things and I often wondered whether it was a personal thing or whether there was a real study given to the thing?

Admiral DIXON. I would like to correct the impression.

I had been in the Bureau of Aeronautics quite a bit in the last 15 years, in my shore duty, coming from sea and I have been with Captain Roby and I saw him start this program and was alongside him when he pushed it.

I did not have a controlling voice in it but I did certainly not object to it.

Mr. TEAGUE. One reason this thing irritates me is that recently a young scientist in an important place in the Defense Department said there are all kinds of teams in the Defense Department who are failing to accomplish their missions and the Defense Department knows they will fail.

As you say, we cannot expect a product from every one of these teams and we realize that but this man contends you can take teams over there and pinpoint those who have failed to carry out their projects and they knew they would not carry them out.

That is the reason it just makes a lot of us look kind of silly who support you people and who support the research and development program.

Admiral DIXON. Mr. Teague, if you have any indications of such in my Bureau, I would like to know about them.

Mr. TEAGUE. I am going to ask this young man if he knows and I will let you know.

The CHAIRMAN. Admiral, may I ask you, for the benefit of the committee, to tell us how far this decision is going to affect the future of the Navy? What programs will it affect, operational programs, for instance? What type of aircraft, what type of missile?

Admiral DIXON. It will not affect any of our programs, Mr. Chairman, that are operating in the fleet or that we have destined for the fleet.

The CHAIRMAN. What programs are you anticipating it will affect?

Admiral DIXON. This is an R. & D. endeavor entirely within the Naval Establishment and will have no operational effect.

The CHAIRMAN. In the Air Force it will affect certain programs but you tell me in the Navy it will not affect any program.

Admiral DIXON. Right.

The CHAIRMAN. And you were making the fuel with the idea you would need it but you have no program that is affected by the production of the fuel?

Admiral DIXON. We were making the fuel, in order to find an application for the fuel. For operational use.

The CHAIRMAN. You were making the fuel to find some application?

Admiral DIXON. Right.

The CHAIRMAN. So, after you got the fuel, you were going to try then to develop a machine that would consume it.

Admiral DIXON. Right.

The CHAIRMAN. Is that right?

Admiral DIXON. Yes.

The CHAIRMAN. It does not sound right. Normally, you would have the machine first but in this case you are going to get the machine after you get the fuel.

Admiral DIXON. You might say we had the machine, Mr. Chairman, in that we had the airplane. We have to put an engine in the airplane and if the engine will burn a fuel of the performance we expected from it, then it is very attractive.

The CHAIRMAN. Did you not know of the cost and toxicity of this fuel and other impediments to start with?

Admiral DIXON. Yes, sir.

The CHAIRMAN. Did it take you this long to find out that the toxicity was a really serious situation?

Admiral DIXON. That was not the controlling factor in our decision. It was important but not controlling.

The CHAIRMAN. You mentioned the high cost. You knew it was going to be expensive all along?

Admiral DIXON. Yes, sir.

The CHAIRMAN. And the question of moving it from place to place was always known. It was a difficult problem. So, those really were passed upon initially?

Admiral DIXON. Yes. I would like to call to mind the difference in outlook of 7 or 8 years ago, as regards airplanes, and now, Mr. Chairman. If we had the same atmosphere existing now that did then, I feel we would be going ahead with this project.

The CHAIRMAN. You mean now after 7 years you are facing the fact that the missile is going to take over a lot of the manned aircraft?

Admiral DIXON. The missile and other concepts are influencing our operational decisions; yes, sir, very definitely.

The CHAIRMAN. This was a missile fuel or an aircraft fuel?

Admiral DIXON. It started from its origin really as a turbojet fuel for aircraft. That was the original concept.

The CHAIRMAN. But when you use the boron, now, isn't it a missile fuel?

Admiral DIXON. Well, you have this heat content that has application to any fuel whether it is solid, liquid, and any application, whether an engine or a rocket or anything.

The CHAIRMAN. You were going to use this fuel interchangeably between airplanes and missiles?

Admiral DIXON. No, sir; our original concept was to utilize it in aircraft, sir.

The CHAIRMAN. When did you change to use it in missiles?

Admiral DIXON. We have not changed entirely. We are still investigating its application to missiles in a very small research program, but we have not changed our goal in that we are going to reflect the whole project to missiles and have an immediate application for this fuel.

The CHAIRMAN. In fairness to the Navy there was a recommendation by an eminent group of scientists—do you have the names and the background of each one of those people who recommended that?

Admiral DIXON. I have some, Mr. Chairman; yes, sir.

The CHAIRMAN. Could you get all of those and put those in the record so the committee and the country, too, may know what scientists recommended it before we entered into that program?

Admiral DIXON. I will make this list available.

The CHAIRMAN. Who recommended this ZIP program; isn't that right?

Admiral DIXON. I have a list here I will make available to the reporter.

The CHAIRMAN. Could you read them quickly?

Admiral DIXON. This is the subcommittee of the Killian Committee, sir.

David C. Acker, chemical engineer, Arthur D. Little, Inc., Cambridge, Mass.

Edward L. Cochrane, vice president in charge of industrial and governmental relations, MIT.

Arthur C. Cope, head, Department of Chemistry, MIT.

Walter Doll, technical and research engineer, Pratt & Whitney Aircraft, East Hartford, Conn.

A. W. Fisher, Jr., chief, process engineering group, Arthur D. Little, Inc., Cambridge, Mass.

Nicholas J. Grant, associate professor of metallurgy, MIT.

George B. Kistiakowsky, Abbot and James Lawrence professor of chemistry, Harvard University.

Herbert R. Lawrence, assistant head, aerodynamics research department; head, propulsion branch, Cornell Aeronautical Laboratory, Buffalo, N.Y.

Warren K. Lewis, professor of chemical engineering, MIT.

Bruce S. Old, vice president in charge of chemical and metallurgical engineering, Arthur D. Little, Inc., Cambridge, Mass.

Ascher H. Shapiro, professor of mechanical engineering, MIT.

C. Richard Soderberg, dean, School of Engineering, MIT.

H. Guyford Stever, associate professor of aeronautical engineering, MIT.

Glenn C. Williams, professor of chemical engineering, MIT.

Robert B. Woodward, Morris Loeb professor of chemistry, Harvard University.

Jerrold R. Zacharias, director, laboratory for nuclear science, professor of physics, MIT.

Dr. Killian, Massachusetts Institute of Technology.

Dr. Hugh L. Dryden, National Advisory Committee for Aeronautics.

Mr. KARTH. When was construction stopped on the last ZIP plant?

Admiral DIXON. Our construction at Muskogee was stopped about 10 days ago, sir, but it was practically complete, sir.

Mr. KARTH. In your testimony on page 3, you say:

> In 1958, emphasis in the Navy shifted from high performance attack and fighter aircraft to slower aircraft that were to perform as platforms for high performance missiles.

What month in 1958? Could you give us an approximate time?

Admiral DIXON. The word "emphasis" covers too much time, sir. I cannot give a particular time. It is a gradual evolution, but it finally crystallized in 1958.

Mr. KARTH. As a result of this shift of emphasis, the Navy requirements for high energy fuel was reduced by approximately 25 percent at the Muskogee plant; is that right?

Admiral DIXON. From 75 to 25 percent.

Mr. KARTH. In June 1959, the Bureau of Aeronautics recommended termination of even that production at Muskogee; right?

Admiral DIXON. Yes; because in 1958 we still had some thoughts of ramjet application of this fuel, and that would require about 25 percent of the production, but since then our emphasis has turned to other fields.

Mr. KARTH. You say:

> In June of 1959, the Chief of the Bureau of Aeronautics recommended termination of the Muskogee production contract.

Admiral DIXON. I thought you said "terminated." I recommended, but we did not terminate at that time.

Mr. KARTH. Despite the fact you did not need it, it was not terminated; is that correct?

Admiral DIXON. That is correct, sir; because had the Air Force programing gone along, this fuel would have been required. In fact, much more would have been required, so I could not terminate this fuel with a possible Department of Defense use for it.

Mr. KARTH. Despite the fact that in June 1959 you recommended its termination.

Admiral DIXON. Unless there was a requirement for it.

Mr. KARTH. And the determination apparently did not occur even during that time when you apparently had little or no use for this fuel, instructions were being carried out in the month of June 1959 on two other plants that you would not need if you had no use for the Muskogee plant, until just a week or so ago, with the apparent additional cost of several millions of dollars; right?

Admiral DIXON. That is not exactly correct, sir.

Mr. KARTH. What do you mean exactly?

Admiral DIXON. The plant was almost complete and we did pay for the operation during this period, but I would like to point out that this is a Department of Defense problem. I cannot terminate a project without their concurrence because another service might need the product from that plant.

Mr. KARTH. I am not blaming you, sir. I say that you recommended in June 1959 that production cease.

Admiral DIXON. Yes, sir.

Mr. KARTH. Despite that fact, construction continued on the two plants that you would not need if you did not need the production on the one that you had.

Admiral DIXON. There was an existing requirement for the fuel, sir, at that time.

Mr. KARTH. An existing requirement for the fuel; but do you not think that although there was an existing requirement, that certainly because the Muskogee plant had been cut 75 percent in production that, whatever the existing requirement was, certainly the Muskogee plant could have taken care of that existing requirement?

Admiral DIXON. Sir, there had been no fuel produced in this plant. It was to go into production this month.

Mr. KARTH. In the Muskogee plant?

Admiral DIXON. Yes, sir. There had been no fuel produced in June.

Mr. KARTH. And during that period of time you had construction going on in the other plants?

Admiral DIXON. It was approximately 85 to 90 percent complete at that time.

Mr. KARTH. Let me ask you this: How much money did you actually spend on this whole project between June 1959, when you recommended that production cease, and last week, when you executed the whole program?

Admiral DIXON. I would say between $1 million and $2 million, sir.

Mr. KARTH. Mr. Chairman, I concur with our colleague from Texas here that certainly a complete investigation should be made of this thing. I just do not think the taxpayers of this country can afford the luxury of these mistakes.

The CHAIRMAN. I want to say to all the members of the committee we are going to have a complete investigation of this, and I hope the members of the committee will stand with me as we go into the details of the investigation.

It is my hope, after these hearings are over, we will have the opportunity, perhaps before Congress adjourns, to go out and actually see these plants, so that we will know firsthand how they look, what has been done, and what the taxpayers' money bought, and where it has gone.

Now, Mr. Daddario——

Mr. DADDARIO. Your report indicates at the time these programs started you had great faith in this type fuel so you could have aircraft to cover long ranges at high speed. And now you have shifted to the slow-moving platform which I imagine also has long range but moves slower.

Now, you also have had a program of developing an atomic-driven engine.

What did this program have to do with slowing down the development of an atomic-driven engine during this same period?

Admiral DIXON. I can think of none, Mr. Daddario.

Mr. DADDARIO. There was a shift, was there not, because of the prospective use of this fuel in research and development, so that there was a corresponding slowdown in the atomic energy field, insofar as aircraft engine was concerned?

Admiral DIXON. I do not think the programs are interrelated at all, sir, in that regard.

Mr. DADDARIO. You do not think there is any connection whatsoever between the two?

Admiral DIXON. No.

Mr. DADDARIO. Did you at any time, when the decision was made to support this kind of fuel for engines, have any connection with the atomic energy program insofar as the corresponding use for an atomic engine was concerned?

Admiral DIXON. No, sir; I had no connection with that program at the time.

The CHAIRMAN. Mr. Hechler——

Mr. HECHLER. Admiral Dixon, how much would you estimate would be expended in fiscal year 1960?

Admiral DIXON. I would make just a guess which I think would be fairly accurate. Depending on when we finally decide what to do with the plant, $1 million or $2 million.

Mr. HECHLER. Would this be predicated on a negative decision by the working group?

Admiral DIXON. That is correct. I am thinking only from our own requirements that if the operation is stopped completely.

Mr. HECHLER. Now, these 125 employees that you said would be on the payroll for keeping the plant in standby status, they would be on the Navy payroll, right?

Admiral DIXON. Yes, sir.

Mr. HECHLER. Assuming a negative decision on the joint working group in special fuels in September, how many of those employees would remain on the payroll for how long?

Admiral DIXON. If the decision is negative by October 1, I will have to take action to terminate the projects.

Mr. HECHLER. You could presumably then cut down the $1 million that you estimated?

Admiral DIXON. When I said a million dollars, I am speaking about June 30 through possibly October, but that is a very approximate figure.

Mr. HECHLER. I think now that we have reached this point everyone is interested in seeing that expenditures come to a halt.

Admiral DIXON. And so am I, sir, unless there is something productive out of the plant.

Mr. HECHLER. It seems to me that 125 is a rather large figure. That is just my reaction. I wonder what those people are being used for.

Admiral DIXON. I think the Callery people could answer that much better than I but we have some very complicated process that has to be watched very carefully and also they have to have know-how to do anything in the plant and we have to keep a nucleus if we are going to find a use for this plant in the immediate future.

The CHAIRMAN. Mr. Moeller.

Mr. MOELLER. Is there anything in your testimony here that you would like to say and could not possibly say because of security reasons?

Admiral DIXON. Mr. Moeller, I think it might have been a more interesting hearing if we had disregarded security but I do not know that it would have added so much to it.

We were getting a little closer to it a few minutes ago.

Mr. MOELLER. You made the statement twice, I believe that the Air Force had been invited to join with you on this and they declined.

Now, without hearing from them, could you tell us, do you know why they declined?

Admiral DIXON. Well, apparently on a requirements basis. They did not need the fuel. They had a project and we had hoped that they might need the fuel output from this plant but when their requirement evaporated, of course they were not interested in taking over the plants.

Mr. MOELLER. Now, a third question, Admiral: Do you know of any employees in either of these companies formerly with the military services and with the Defense Department and if you do know of such, if you cannot name them now, could you put them in the record?

Admiral DIXON. Now I know of none, sir.

Mr. MOELLER. Connected with the military.

Admiral DIXON. No, sir.

(The information requested is as follows:)

DEPARTMENT OF THE NAVY,
BUREAU OF AERONAUTICS,
Washington, D.C., August 31, 1959.

Hon. OVERTON BROOKS,
Chairman, Committee on Science and Astronautics,
House of Representatives, Washington, D.C.

MY DEAR MR. CHAIRMAN: During my appearance before your committee on August 26, 1959, on the subject of the Navy's termination of our contract with the Callery Chemical Co. for the production of high-energy fuels, I was asked for the names of former employees now employed by industry. I replied at that time that I knew of none.

It has since been brought to my attention that the following men, formerly with the Bureau of Aeronautics, are now employed in industry:

With Olin-Mathieson Chemical Corp.: Capt. Harry Sosnoski, USN (retired); Mr. Benjamin F. Coffman (former civil service Bureau of Aeronautics).

With Callery Chemical Co.; Capt. Josef M. Gardiner, USN (retired).

Sincerely,

R. E. DIXON,
Rear Admiral, USN, Chief of Bureau.

Admiral DIXON. I would like to, if I may, make one statement, that our relations with Callery have been as fine as I have ever seen between the executive department of the Government and a commercial contractor. They have done the job; they have done a wonderful job, and it is with a great deal of distaste that we appear before you this morning, sir, I can assure you.

The CHAIRMAN. Mr. King.

Mr. KING. Admiral, just one little line of inquiry: You have mentioned two large installations that have been in the process of construction and that construction has now been brought to a termination at just the 99-percent point of completion.

You have stated that unless some other department of the Government or private company is able to find some usefulness for these installations, that they will, in effect, become surplus and sold for scrap so to speak, at, I suppose, 10 cents on the dollar, or something like that.

Admiral DIXON. We hope not, sir.

Mr. KING. I hope not, too, but let me pursue this.

If the architects, the engineers, and planners who first conceived these installations, had they been aware of the fact that there was a possibility that the program might be discontinued, is it not possible that they could have so constructed the plants that a changeover could have been made and that the plants could have been put to some other use without this terrible waste and loss on our hands?

Admiral DIXON. Mr. King, I am not sufficiently an industrial engineer to properly answer your question. I think, had we gone from the start with that concept, possibly, no doubt, you were right, but this is a very difficult, expensive operation to produce this fuel, and I am sure that to any engineering department, any firm, that would be an overriding consideration, to get the best plant possible for this use.

Mr. KING. Do you think the question I have just asked is one that would bear more fruitful investigation? Would that be a line of inquiry that we might well pursue a little further?

Admiral DIXON. I certainly think it is worth considering, sir.

Mr. KING. I would just like to express myself, Mr. Chairman, that that is a line of inquiry we could pursue on this matter.

Mr. FULTON. Would the gentleman yield at that point?

The CHAIRMAN. I was going to do this, if I may say so. We have made the rounds of the committee. I want to recognize Mr. Fulton now, and after that, Mr. Miller, to make a statement, and then we will proceed with the next witness.

Mr. FULTON. I would just prefer to have Mr. King yield for a question, and I will yield to Mr. Miller.

On the questioning that Mr. King is doing, it might be a little expensive, but if he could put out that this might be used to make a dry bleach for household laundering, we could use the plants for borax or some kind of a dry bleach, or something of that type, that women could use in washing machines. A quarter of a billion dollars for that purpose might be a little expensive.

The CHAIRMAN. Mr. Fulton, do you have any further questions at this time?

Mr. FULTON. I will yield to Mr. Miller.

Mr. MILLER. You use your own time. I have mine.

Mr. FULTON. Was there a difference of opinion between the Air Force and the Navy as to the termination or reduction of these programs? It seems that the Navy was contacting the Air Force several times and the Air Force kept saying "No" and the Navy kept hoping they would say "Yes", so they kept on going on the possibility there might be a use for this fuel.

What happened on that?

Admiral DIXON. Well, as I understand it, sir—I can't speak for the Air Force, but as I understand it, the requirement really did not expire until we were told by the Air Force that they no longer had a requirement for this high-energy fuel.

Mr. FULTON. When did they say they were not going to go ahead and they started to reduce? When did you have a difference of opinion?

Admiral DIXON. I think the Air Force could better answer that, Mr. Fulton.

Mr. FULTON. That is all.

The CHAIRMAN. If there are no further questions, I will call on Mr. Miller.

Mr. MILLER. Gentlemen of the committee, I just want to leave this thought with you: I think we have given the admiral a pretty rough time on this.

I would hate to see the time when we are going to clamp down on R. & D., and the ability to go in and discover new things, because R. & D. is costly. We will be in a very poor way when we reach that stage.

Now, I don't want to see public money spent any more than the rest of you, and I like to think that what is spent is spent well and that it can be spent well.

I think most of us realize that when a project is initiated it is inherently impossible to predict with certainty whether the gamble will pay off, but that the starting of such a program is justified because such programs in general are necessary to further progress. Every time we fire an Atlas and it doesn't go into the air, we waste a few million dollars, but that isn't going to deter us because we know we can do it.

Now, I think that Admiral Dixon's record in the Navy is most eminent, he is well qualified in every way for his job, and his interest in the Government is just as much as our interest.

I realize this is expensive, but this is war and what is war? It is wastage. Look at the shipyards deteriorating and rotting. We can say now if we kept up the merchant marine we wouldn't need in time of war to build shipyards. If we kept up in our defenses we wouldn't need to spend millions of dollars in trying to catch up.

If a new fuel was indicated at that time and we spent some money in getting it, I am not for saying that the money wasn't well spent.

Now, I am sure if there are any places where the Navy and the Air Force can eliminate these things—and I don't say we shouldn't look at them and look at them very carefully, as that is our job. But I don't like to see the implication that people just wantonly go into these things and I am afraid that feeling has been left here today. I just want to speak in defense.

We are asking men to go into science. We are encouraging men to go into it and then we begin to hold them up and say, "If you make a mistake, what have you done? You are not qualified."

I think this committee has to take a look at that. It has to be critical of scientists but it also has to protect scientists and the people who do R. & D. work, to stand between them and undue criticism.

I have felt that perhaps we have been a little supercritical or hypercritical today.

Mr. KARTH. Will the gentleman yield?

Mr. MILLER. I yield.

Mr. KARTH. So the gentleman from California doesn't misunderstand what I was attempting to say, certainly I support research and development and I know there will be times when research and development doesn't produce the end result we intended to produce. This, of course, is obvious but my point is this, that when R. & D. gets

to a point when there is no longer any use to proceed and we still spend millions of dollars on a project—a then worthless project—this is where I say we should put our foot down.

Mr. MILLER. I didn't even have you or anyone else in mind, Mr. Karth. I agree with you thoroughly.

There is a point where you have to have the cutoff and it is sometimes hard to stop some of these things in Government due to our own government bureaucracy, just as it is difficult to get them started.

The CHAIRMAN. I will now recognize the Admiral and then refer to Mr. Teague.

Admiral DIXON. There was a requirement for the output of this Muskogee plant until very, very recently. That requirement expired and then we terminated.

Mr. KARTH. How many plants did you have, Admiral?

Admiral DIXON. We had two 5-ton-day plants. We had one and the Air Force had one.

Mr. KARTH. Was there a requirement for them?

Admiral DIXON. If the Air Firce program continued there was requirement for those and more, sir.

Mr. KARTH. Did they indicate a long time ago that the emphasis was shifting as you indicated it was shifting in the Navy and certainly there would be less requirement?

Admiral DIXON. No, sir, we had a requirement for this fuel continuously. That is all I was familiar with, sir.

The CHAIRMAN. Mr. Teague?

Mr. TEAGUE. Admiral, I want to say don't consider we have given you a hard time and certainly I didn't intend to, but I think we do you a greater disservice by not looking into this thing and trying to do something about it than we do by just sitting back on our hands and saying, "Well, it is research and development so forget about it."

I think we have to look at every program. For sure, I will put my votes against anybody for not supporting research and development and I will continue to do that, but I will continue to be as critical as I know how to have this much money go down a hole and nothing come from it.

Admiral DIXON. The R. & D. dollar is just as important to us as the procurement dollar.

Mr. TEAGUE. That is correct, and if you get checked on you will probably do a better job. Just as we get checked every 2 years.

The CHAIRMAN. The question came up as to whether or not we should go into this matter. I have always been one who believes that the best interests of the U.S. Government is served by giving the public the facts. And so the purpose of this hearing is to permit the admiral—and he is a distinguished officer in the Navy and has a wonderful record behind him and we recognize that, but it is to give the public the facts and let the chips fall where they may. And I am not trying to point the finger at anyone, nor am I trying to hold back on anything. But I do think when the Navy comes up here and has a full opportunity to be heard and presents their case, they are getting the best possible break that this committee can give to them.

I have been telling my people around where I have talked that the emphasis has shifted from manned aircraft to missiles and I have been

doing that for several years. I think now the Navy sees that that is the case.

Admiral DIXON. Mr. Chairman, may I say, if I gave the impression that I appeared before this committee without some trepidation and regret this morning, I apologize. This is a very distasteful job for us to do as public servants.

The CHAIRMAN. I want to say this to you: Do you think the committee has been fair to you in giving you an opportunity to be heard?

Admiral DIXON. Very definitely.

The CHAIRMAN. May I ask you two more questions that I have been asked by members of the committee to ask you.

In the first place, this question was asked of me to present to you:

Is the decision to terminate the ZIP program a technical decision, or was that in any way a budgetary decision?

Admiral DIXON. It is purely technical, sir.

The CHAIRMAN. It is not due to any outside influences to save money?

Admiral DIXON. No, sir, but I think any technical decision, Mr. Chairman, is influenced by any number of other factors, but this is strictly a technical decision.

If we had unlimited time, personnel, money and everything, possibly we wouldn't terminate so fast, but I would say it is purely dictated at the moment by technical reasons.

The CHAIRMAN. Well, if you are not going to get any results, I don't think you are fast about terminating it there.

One more question I have been asked by a member of the committee to ask you: If you will place into the record on the civilian side of people who recommended this, in addition to them, any military personnel who recommended this.

Admiral DIXON. Yes, sir.

The CHAIRMAN. If you will present that to our staff we will put it in the record.

(The information requested is as follows:)

MILITARY OFFICERS THAT REVIEWED AND APPROVED PROJECT ZIP

Name and position:

Rear Adm. T. S. Combs, Chief, Bureau of Aeronautics, 1951–53
Rear Adm. A. Soucek, Chief, Bureau of Aeronautics, 1953–55
Rear Adm. J. S. Russell, Chief, Bureau of Aeronautics, 1955–57
Rear Adm. R. E. Dixon, Chief, Bureau of Aeronautics, 1957 to present

JOINT WORKING GROUP ON SPECIAL FUELS

Present membership:

Dr. R. C. Gunness, Standard Oil Co. (Indiana), Chairman
Mr. A. J. Nerad, General Electric Co., member
Dr. H. C. Brown, Purdue University, member
Mr. C. H. Winter, Du Pont, member
Dr. E. R. Gilliland, Massachusetts Institute of Technology, member
Mr. D. Gesdan, Allison Division of General Motors, member
Mr. A. M. Rothrock, National Aeronautics and Space Administration, member
Dr. D. P. Barnard, Director of Defense (R. & E.), member
Mr. J. W. Crellin, Army, member
Comdr. R. Koch, Navy, member
Mr. A. Eaffy, Air Force, member
Mr. M. P. Dunnam, Air Force, member
Mr. D. B. Brooks, Director of Defense (R. & E.), secretary

Original membership (1952):
Dr. R. C. Gunness, Standard Oil Co. (Indiana), Chairman
Mr. A. M. Rothrock, National Aeronautics and Space Administration, member
Mr. A. J. Nesad, General Electric Co., member
Mr. William Littlewood, American Airlines, member
Capt. H. Sosnoski, Navy, member
Lt. Col. L. F. Ayres, Air Force, member
Mr. C. E. Saunders, Army, member
Mr. E. L. Klein, Research and Development Board, panel director

Others who have been members of Joint Working Groups on Special Fuels (1952–59):
Capt. F. A. Roby, Jr., Navy
Capt. H. N. Houck, Navy
Comdr B. L. Towle, Navy
Comdr. V. A. Schweitzer, Navy
Lt. Col. R. J. Burger, Air Force
Lt. Col. E. Fincke, Air Force

Mr. QUIGLEY. When was construction on the Muskogee plant actually started?

Admiral DIXON. In 1956 we signed a contract—in June 1956 we signed a contract for the construction and I think it started shortly thereafter, sir. March 9, 1957, it was actually started.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. I would like to say to the admiral he has made a good presentation here and that while our questions have been direct and probing they are nevertheless not prejudging questions nor are they slanted. They are aimed at getting the facts and I have not prejudged this particular matter.

I would say for the admiral that I thought he was going to recall that President Eisenhower in a message to Congress early this year, I would say it was in about January or February of this year, pointed out the boron high energy fuel program as of major importance to the defense effort of this country, so there was that emphasis as a national policy early this year.

Admiral DIXON. Yes, sir.

Mr. FULTON. The question comes, if there is going to be cancellation, how about the other contracts there might be that are in question. For example, there is one of the AFN Corp. owned by the American Potash Co. I understand there is a contract with them. Also one with the Food Machinery & Chemical Corp., also with National Distillers and Aerojet Stoker Co. What happened to those contracts?

Admiral DIXON. Those are not our contracts, Mr. Fulton.

Mr. FULTON. Who are they with?

Admiral DIXON. Air Force contracts.

Mr. FULTON. So every contract then that the Navy has is being canceled?

Admiral DIXON. That is correct, unless there is a requirement established by the Defense Department to keep these open for someone else.

Mr. FULTON. How big a program for research and development on these high energy boron fuels do you have in existence now? Could you give us what the budgetary cost of that is in the Navy's budget?

Admiral DIXON. Would you repeat that, sir?

Mr. FULTON. What kind of an R. & D. program do you have on now, for a limited R. & D. program for these high energy boron fuels? What is the cost of it in the Navy budget?

Admiral DIXON. We have a ramjet project continuing at Pratt & Whitney and we have fuel for that——

Mr. FULTON. What is the size of that contract and what type is it?

Admiral DIXON. $700,000 at Pratt & Whitney.

Mr. FULTON. Over what period?

Admiral DIXON. 6 months.

Mr. FULTON. Is that new? Why don't you keep it with these other companies where you are canceling out?

Admiral DIXON. This is an engine development project, Mr. Fulton. Pratt & Whitney Aircraft Engine Co.

Mr. FULTON. Are you continuing any research and development program on boron in relation to torpedo engines?

Admiral DIXON. We are continuing it on a very small basis researchwise in liquid and solid propellants, but it is a very small endeavor, sir.

Mr. FULTON. Do you have any program on research and development in the Navy cooperating with this use of boron as an element to destroy cancerous or tumorous cells, in medical approaches? Are you continuing that?

Admiral DIXON. It may be that the Office of Naval Research is in that with the medical people. We are not in the Bureau of Aeronautics, Mr. Fulton. We will have to check on that; I don't know.

Mr. FULTON. That is all.

The CHAIRMAN. Thank you, Admiral.

Before you leave, will you give us a list of the universities and colleges and other institutions that have contracts along the line of the ZIP program? That is, for the development of high-energy exotic fuels with the Navy.

Admiral DIXON. We will do that.

The CHAIRMAN. We will put that in the record.

(The information requested is as follows:)

UNIVERSITIES WORKING IN THE FIELD OF BORON CHEMISTRY FOR THE NAVY

Office of Naval Research:

1. University of Minnesota
2. Polytechnic Institute of Brooklyn
3. Cornell University
4. Ohio State University
5. Penn State University
6. Rutgers
7. University of Southern California
8. University of Pennsylvania
9. Oregon State University

Bureau of Ordnance: Johns Hopkins University

The CHAIRMAN. Thank you very much, gentlemen.

Now, the next witness we have here is the Assistant Secretary of the Air Force, the Honorable Joseph V. Charyk.

Have a seat, Mr. Secretary.

Do you have anyone who would like to sit with you?

Mr. CHARYK. I have Mr. Weitzen of my staff on my left, and Colonel Miller of the Office of the Deputy Chief of Staff for Materiel, on my right.

The CHAIRMAN. You have a prepared statement, sir?

Mr. CHARYK. Yes, I do.

The CHAIRMAN. Will you proceed with that statement?

STATEMENT OF JOSEPH V. CHARYK, ASSISTANT SECRETARY OF THE AIR FORCE, RESEARCH AND DEVELOPMENT; ACCOMPANIED BY WILLIAM WEITZEN, DEPUTY FOR RESEARCH AND DEVELOPMENT OPERATIONS, AND LT. COL. SAMUEL F. MILLER, DEPUTY CHIEF, PROPULSION BRANCH, OFFICE OF THE DEPUTY CHIEF OF STAFF, MATERIEL

Mr. CHARYK. Thank you, Mr. Chairman.

Mr. Chairman and members of the committee, the early history of the alkylborane high energy fuel program has been described by Admiral Dixon.

During the early years the Air Force was an interested observer of this program, being actively engaged at the time in fuel research along other lines.

Air Force interest increased, however, and in July 1955 $4 million of fiscal year 1956 Air Force funds were contributed to the Navy program.

In mid-1956 the Air Force, at the invitation of the Navy, agreed to take over and assume financial support of the fuel research, development, and production effort at the Olin Mathieson Chemical Corp. The Navy retained sponsorship of a similar program at the Callery Chemical Co.

When the Air Force assumed the program at Olin Mathieson, there were in existence and functioning only laboratory and bench scale apparatus for making very small amounts of fuel.

The desired boron compounds had been identified, some of their properties were known, and the chemical processes for manufacturing them had been worked out and proven in small scale.

The two most pressing problems were to check the process data in larger scale apparatus and to produce sufficient fuel to perform more extensive testing on the fuel itself and to begin designing engine hardware that would be compatible with it.

Toward these ends the Navy had under construction a plant capable of producing eight-tenths ton of boron fuel per day, and had plans for a plant that would produce 5 tons per day. The Air Force continued support of both and brought them both approximately to completion.

In the meantime, Olin Mathieson constructed a 400-pound-per-day plant as a corporate venture, with a view to selling fuel to the Air Force. This plant started producing fuel in the fall of 1957 and continued until the spring of 1959.

Every step in this program has been attended by risks. In the beginning there was little fuel available for experimentation to determine the fuel properties and the design features of engines employing this fuel.

Investments in laboratory facilities had to be made in order to obtain fuel to further evaluate the fuel itself and to learn how to build hardware to use it. This led to a progression of facilities of successively large size and increasing cost.

The construction of the 5-ton-per-day plant, for the purpose of obtaining fuel to develop an engine for the use of HEF in the B–70, was a step in this progression. The 5-ton-per-day plant is virtually complete at this time.

At the time the Air Force began support of this program in 1955, we had no indication of the reliability and results we could expect from the then infant ballistic missile program.

Consequently, it was deemed necessary to continue emphasis to develop improvements in air-breathing engines if we were to anticipate utilization of their full potential.

At the time that the decision to proceed with the 5-ton-per-day plant was made, the planned long-range strategic bomber, later to become the B–70 Valkyrie, had emerged as the leading candidate for this new fuel. In order to provide fuel for the timely development and qualification for the B–70 jet engine, the 5-ton-per-day plant had to be started.

For some time it has been growing more apparent that all of the early promise of the boron fuel would not be realized on a timely and economical basis. Also, due to improvements in the efficiency of the B–70, the added range available through HEF has become less critical.

Accordingly, a decision was made to terminate the development of the J–93–5 engine, which is the version of the B–70 engine that was to use HEF in the afterburner, and to discontinue the fuel plant operations which were necessary to sustain this engine development program.

Further, the advanced Bomarc, which was another potential user of boron fuels, had not become an active program. Therefore, there are no development requirements for the quantities of fuel which the 5-ton-per-day plant is capable of producing.

It must be emphasized that the Air Force high-energy fuel program has not been terminated. We have asked our technical staffs at AMC and ARDC for a plan for the orderly shutdown of the 5-ton-per-day plant, for their review of the recommendation concerning the R. & D. program for HEF and for their analysis of the fuel requirements needed to sustain such an R. & D. program.

We do have and expect to continue an active R. & D. program in the application of boron compounds to rocket propellants, as well as advanced ramjets. The present action affects the use of HEF in the B–70 and the engine and fuel plant programs which supported that application.

The CHAIRMAN. Thank you very much, Mr. Secretary.

As I understand, then, the B–70 and the Bomarc programs are the ones affected by this order; is that correct?

Mr. CHARYK. The B–70 is affected. The high-energy fuel possibility in the Bomarc has been under study. It is not a part of the Bomarc program as the program is constituted at the present time.

The CHAIRMAN. Will the Bomarc program proceed, or is that affected or canceled by this decision?

Mr. CHARYK. At the present time, the Bomarc will be limited to the use of hydrocarbon fuels.

The CHAIRMAN. Your Bomarc program will proceed, then?

Mr. CHARYK. That is correct.

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The CHAIRMAN. Are there any other programs affected by this decision?

Mr. CHARYK. These are the only two programs.

The CHAIRMAN. I notice your statement doesn't give us figures—I mean dollar figures. It gives only one figure, and that is $4 million; but what is the total investment of the Air Force in this program?

Mr. CHARYK. I might summarize that for you, sir. The process development through fiscal year 1959 amounts to $23.5 million. The amount spent on facilities by the Air Force is $53.3 million. There are additional items such as the 5-ton-a-day plant startup costs, which amount to $9.7 million, and sodium boro hydride for the 0.8-ton plant, $7 million. These together with the costs for fuel purchase constitute a total expenditure of $107.1 million. To this we should add the work on the J–93–5 engine, $8.7 million and the work on the Marquardt RJ–43 ramjet of $4.4 million, making a grand total of $120.2 million.

The CHAIRMAN. It is approximately the same as the Navy in amount?

Mr. CHARYK. Slightly less.

The CHAIRMAN. Are the General Electric J–93–5 program and the Marquardt RJ–43 program total losses?

Mr. CHARYK. The J–93–5 program has been terminated. There has been information, of course, derived from the program on the combustion characteristics in the J–93 afterburner. The Marquardt program has actually involved flights of ramjet engines at supersonic speeds, and as such, has provided useful information which might have potential in the future, if there are further applications of high-speed ramjet engines.

The CHAIRMAN. Now let me ask you this: Have you closed down the plants referred to in your statement?

Mr. CHARYK. We have given direction to the Air Materiel Command and to the Air Research and Development Command to prepare a plan for the orderly termination of the 5-ton-a-day plant and we have also asked them for their latest research and development plan, the fuel requirements to support such a plan, and we have received their report in the last few days.

The CHAIRMAN. What did they report to you?

Mr. CHARYK. Well, they went into details as to the various ways in which the plant could be terminated in orderly fashion. They reviewed the various research and development requirements and these recommendations are under review at the present time.

The CHAIRMAN. There has been no decision made in reference to them?

Mr. CHARYK. No decision has been made as to——

The CHAIRMAN. Have you any plan at all as to the future use of these plants?

Mr. CHARYK. There will be a continuing requirement for certain boron compounds, primarily in connection with our rocket propellant program. The best source of the materials is one of the items that is is in the ARDC study.

The CHAIRMAN. Then your future use for the boron propellant is not in the aircraft program, but in the missile program?

Mr. CHARYK. Our research and development effort, as we see it, is primarily in the rocket area, unless there should develop a future requirement for a high-speed ramjet engine.

The CHAIRMAN. What percentage of the need will be indicated in the future use of the planes?

Mr. CHARYK. As far as aircraft are concerned, we do not see further application. Missiles employing ramjet engines might be another story.

The CHAIRMAN. Well, what is that story; what percentage would you need there?

Mr. CHARYK. Well, the total amounts that would be required would depend, of course, on the scope of the effort, on the number of vehicles, and so on. I would estimate if we were to pursue strictly an engine development program, that there would be a modest requirement perhaps on the order of 500 tons over a period of a couple of years for an engine development program.

The CHAIRMAN. What percentage is that of the production of these plants?

Mr. CHARYK. Well, actually, the two large plants we have been discussing this morning each have a capacity of 5 tons a day, which is considerably in excess of what you would need for such an engine development program. As a matter of fact, the output from the 0.8-ton-a-day plant would probably be adequate for such an engine development program.

The CHAIRMAN. Just for the benefit of the committee, where are these plants located?

Mr. CHARYK. The large 5-ton-a-day plant is in Model City, N.Y. The 0.8-ton-a-day plant is also located there, and there is also a 40-pound-a-day plant in that general vicinity.

The CHAIRMAN. What was the cost to complete the large plant?

Mr. CHARYK. The plant is virtually complete at the present moment. I don't have the precise dollars that would be required for completion, $44.8 million is the total expenditure to date on the 5-ton-a-day plant.

The CHAIRMAN. $44,800,000?

Mr. CHARYK. That is right.

The CHAIRMAN. How many people does that plant employ at this time?

Mr. CHARYK. Well, I believe that an employment of the order of 700 people had been envisioned. We might have the Olin Mathieson people confirm that. They say 750, sir.

The CHAIRMAN. How many are employed now, Mr. Secretary?

Mr. CHARYK. I think that approximately 700 people are there at the present time.

The CHAIRMAN. Are they in line to lose their jobs?

Mr. CHARYK. Yes, sir.

The CHAIRMAN. So there will be practically no employment in the future in that plant?

Mr. CHARYK. It depends on what the final action is in regard to the large plant. I would presume that if the decision were to place it on some sort of standby basis that certain people would be required for appropriate maintenance. I don't have an estimate here as to the numbers of individuals involved in any standby operation, but it would be considerably less.

The CHAIRMAN. What about the other plants?

Mr. CHARYK. The 0.8-ton-a-day plant is a possibility, a strong possibility for the source of the materials that we will need for our research and development program.

The CHAIRMAN. There is a possibility then that that plant may stay open and in operation?

Mr. CHARYK. Yes, sir, for a period of time.

The CHAIRMAN. What is your investment in that plant?

Mr. CHARYK. The Air Force investment in that plant amounts to $2.3 million. I believe there is also a Navy contribution.

The CHAIRMAN. What is the Navy contribution?

Mr. CHARYK. I don't have that. They tell me $2.2 million.

The CHAIRMAN. Your total investment would be $5.5 million?

Mr. CHARYK. That is right.

The CHAIRMAN. That is at Model City, N.Y.?

Mr. CHARYK. $4.5 million. I am sorry. That is at Model City, yes.

The CHAIRMAN. How many plants do you have in that area?

Mr. CHARYK. Actually there is the 5-ton plant, the 0.8-ton-a-day plant, and there is a 40-pound-a-day plant in the Model City complex.

The CHAIRMAN. You envision, at best, only the need for the small $4.5 million plant? Was that plant built by Mathieson or with Mathieson's money, or was that built by the United States?

Mr. CHARYK. This plant was built with Navy and Air Force funds. The Olin Mathieson Corp. built a 400-pound-a-day plant which is located in Niagara.

The CHAIRMAN. With their own money?

Mr. CHARYK. Yes.

The CHAIRMAN. So they stand to lose how much money in their investment?

Mr. CHARYK. Well, actually, I believe their investment is in the millions of dollars. I don't have the precise number. We, of course, have been buying fuel from the plant so it would be a difficult calculation to assess precisely.

The CHAIRMAN. It wouldn't be a dead loss anyway?

Mr. CHARYK. It wouldn't be a dead loss.

The CHAIRMAN. Let me ask the committee what they would like to do. I thought at first we could finish with these witnesses this morning, but obviously we can't. Tomorrow we have witnesses from Callery and the Olin Mathieson companies here. They have come down for that purpose. I think we have a program in the House that would permit us to be in session this afternoon. My thought is this: It is 11:55. I have a resolution that should be presented to the committee in executive session before we adjourn, and so if it is all right——

Mr. FULTON. May I have just a question?

The CHAIRMAN. Would 2:30 be all right to meet this afternoon?

Mr. Fulton, you have one question.

Mr. FULTON. The question comes up on your statement on page 3:

For some time it has been growing more apparent that all the early promises of boron fuel would not be realized on a timely and economic basis.

That brings up the very serious question: Why was $200 million spent before the decision came to stop, or write the production off? Why did you go so far?

Mr. CHARYK. Actually, the strongest requirement for this type of fuel has existed in the case of the B–70.

Mr. FULTON. Yes, but refer to your own statement:

> For some time it has been growing more apparent that all of the early promises of boron fuel would not be realized on a timely and economical basis.

Here we are with one plant employing 750 people at the taxpayers' expense, when we know they shouldn't be. Why are you staying in business? If I did that I would be bankrupt. Maybe we are going to bankrupt some of the taxpayers. I see nothing in your statement—how much fuel have you gotten for all this money? What amount, in pounds of fuel, have you received overall for the Air Force?

Mr. CHARYK. The statement referred to the fact that the full promise was not going to be realized on a timely and economical basis.

Mr. FULTON. But that has been for some time.

Mr. CHARYK. I did not mean to imply that the fuel would be a dead loss, that the full potential would not be realized. By "full potential" I mean the heat content of the fuel, the most desirable physical properties, the ability to use it throughout the engine, which would permit its maximum exploitation.

Mr. FULTON. Why was the Navy saying "go ahead" and you saying not in some cases, according to your statement? What was the reason for that? There seemed to be a difference of opinion, didn't there?

Mr. CHARYK. In which instance was this?

Mr. FULTON. The Navy kept saying they thought they would keep on with it, based on informal talks with the Air Force. The Air Force declined, but invited further discussion. Again, the Air Force was invited to participate, and again declined in April 1959. And in June 1959 the Chief of the Bureau of Aeronautics recommended termination of the Muskogee production contract, and so on.

You see, obviously there has been a difference of opinion. How much fuel did you get for this money spent by the Air Force? How many pounds total? You were buying fuel, so it wasn't a total loss. How much did you get?

Mr. CHARYK. 200 tons to date.

Mr. FULTON. And a cost of how much a pound?

Mr. CHARYK. It has varied depending upon the plant. I can give you comparative costs, as far as the different plants are concerned. The total cost of the fuel——

Mr. FULTON. 400,000 pounds would cost you $120 million. That is pretty expensive fuel.

Mr. CHARYK. The $120 million is the complete cost of the program to the Air Force. This includes facilities, process development, machinery and equipment, sodiumborohydride plants, the engine development programs, as well as the fuel purchase costs. The fuel from the 0.8-ton-a-day plant that we have purchased amounts to $6.5 million. The fuel from the company-operated——

Mr. FULTON. You can put that in the record later, because I know the chairman wants to do something before 12, and might I say to you I wish you would hold in reserve your opinion as to which plant that you might be running. I don't believe the report of the Arthur D. Little Co. may be the determining factor because they were part of the advisers who recommended this program to begin with. Maybe they aren't the ones to make the decision.

Mr. CHARYK. We have this matter under study.

The CHAIRMAN. The committee will go into executive session and we will reconvene at 2:30 in this room.

(Whereupon, at 12 noon, the committee proceeded in executive session on another subject.)

The CHAIRMAN. Dr. Sheldon, do you have a letter regarding Lieutenant Colonel Schuppener, who was with us up until the session yesterday? If you have that letter, will you read it? I have cited it and I will say for the committee I am sending it to the Department of the Army and I would like it to be a part of the official record of the committee, and that is the reason I ask that it be read in open session.

Doctor, if you will read it.

Dr. SHELDON. Yes, Mr. Chairman.

A letter dated August 26, 1959, addressed to the Honorable Wilber M. Brucker, Secretary of the Army, Washington 25, D.C.

DEAR MR. SECRETARY: This letter is written in appreciation of the services afforded this committee by Lt. Col. Paul B. Schuppener, U.S. Army, during the period of his attachment to the staff of this committee from March 1 to August 22, 1959.

Colonel Schuppener brought to this committee professional talents and experience of a high order of excellence. He also demonstrated a fully cooperative spirit, a keen sensibility for the institutional requirements of Capitol Hill work, and a real skill in making arrangements for the committee's work with witnesses both in and out of Government when such tasks were assigned him.

I wish to mention specifically his lasting contributions to the work of Congress in drafting for committee consideration and adoption the following official reports which have become or will become public documents: "Satellites for World Communication," "The Ground Cushion Phenomenon," "Space Propulsion," and "Dissemination of Scientific Information."

Colonel Schuppener handled his assignments for us in an objective and nonpartisan way, bringing only praise from the members of this committee, our staff, and officials of Government including the other military services. In this respect he served as an excellent ambassador for the U.S. Army. On the basis of this rewarding and happy experience, I can only hope that we can do as well again in the future in having such skilled and perceptive help from a technical staff consultant.

Will you please convey to Colonel Schuppener, and make a part of his permanent jacket, the heartfelt good wishes and thanks of my committee, the staff, and myself for his splendid contribution; and accept our gratitude to the Army for making him available.

Very sincerely,

OVERTON BROOKS, *Chairman.*

The CHAIRMAN. I think there is no necessity for any action to be taken on that, but I think it should be a part of the record of the committee.

Mr. FULTON. I would just only hope the chairman would come into my district and write some sort of a letter for me at the time of the next election.

The CHAIRMAN. May I say to the distinguished gentleman from Pennsylvania, my friend, a member of the committe, that if he does as grand a job for the committee in the course of the 2-year period that Colonel Schuppener did while he was a member of this staff, that I will be glad to write the letter for him.

Now, Mr. Secretary, I am going to begin in reverse, because both Mr. Fulton and I have had one shot at asking you some questions.

Mr. Moeller, do you have some questions?

Mr. MOELLER. No, not at this time.

The CHAIRMAN. How about you, Mr. McDonough?

Mr. MCDONOUGH. I am sorry, I did not hear the testimony.

Mr. BROOKS. Then it comes back to Mr. Fulton and myself.

Mr. Fulton, do you have any questions?

Mr. FULTON. I yield to the Chairman.

The CHAIRMAN. Mr. Secretary, I read your statement and I am interested in what you say, but I though about it since we recessed at noon, and it seems to me that the services are slow in recognizing the situation and that they have wasted money in constructing facilities which they should have known were not going to be usable some time back.

Do you have any comment to make in reference to that?

Mr. CHARYK. Well, I would like to simply indicate that the cancellation of the J–93–5 engine was the factor which indicated that the proper actions on the 5-ton-a-day plant would be to consider an orderly shutdown, in view of the fact that we could meet the bulk of our research and development requirements with fuel available from other plants.

Now, as a matter of fact, I should add that the actions were taken simultaneously. In other words, when the decision was made to discontinue the work on the J–93–5, a prompt decision was made likewise in respect to the course of action on the 5-ton-a-day plant.

In regard to the considerations of the J–93–5 engine, this relates to the importance of the high-energy fuel in assisting in meeting the very critical range requirements for the B–70.

Now the B–70 program has included a very extensive wind-tunnel program and a very great effort has been made in the direction of improving the aerodynamic and the structural efficiency to provide suitable range extensions.

We have finally reached the point where very recently programed performance has been demonstrated through wind-tunnel tests which has meant that the importance of high-energy fuels in achieving our major objectives in the B–70 program are no longer critical. In other words, the improvements in other areas have permitted adequate performance to be obtained without the use of high-energy fuels. These were the considerations, therefore, that led to the cancellation of the J–93–5 and immediately therefore the initiation of actions relative to the 5-ton-a-day plant.

I think when it became clear we could not utilize the output from the 5-ton-a-day plant, prompt action was taken.

Now it could very well have happened that in the course of our wind-tunnel work on the B–70 that we were unable to achieve the kinds of efficiency that now appear to be feasible, in which case the utilization of high-energy fuels in the afterburner would have been very important in meeting the performance requirements which we felt to be necessary for this weapons system.

The CHAIRMAN. Does this decision in effect cancel the B–70?

Mr. CHARYK. No, sir.

The CHAIRMAN. The B–70 will continue as programed in the past?

Mr. CHARYK. It is continuing at the present time as programed.

The CHAIRMAN. But your fuel will be different, that is my understanding; is that right?

Mr. CHARYK. It was always the intention to use hydrocarbon fuels in the engine proper because it had become clear that it was not going to be reasonable to consider the use of high-energy fuels in the engine proper. We had pretty much determined that the application of high-energy fuels to the B–70 would be limited to the afterburner. It was anticipated that the early versions of the B–70 would use hydrocarbon fuels throughout, but that further down the road we would introduce the high-energy fuel afterburner to provide an augmentation in the range.

The CHAIRMAN. Then the fuel, as I understand it, was to be used in the afterburners of the B–70?

Mr. CHARYK. That is correct.

The CHAIRMAN. What are you using in the afterburners of the B–70 to take the place——

Mr. CHARYK. We are going to use a hydrocarbon fuel.

The CHAIRMAN. Is not the boron hydrocarbon?

Mr. CHARYK. These are boron hydrogen compounds. When I say hydrocarbon I am referring to the JP class of fuels.

The CHAIRMAN. Do you have your plants available for the JP class of fuels?

Mr. CHARYK. Oh, yes.

The CHAIRMAN. They are already in operation and you need no increase in capacity of those plants to meet this additional need?

Mr. CHARYK. None at all, and the fuel is of the order of 2 cents a pound, as compared to $5 a pound for the high-energy fuel.

The CHAIRMAN. Of course, you knew that all along. You knew that 7 years ago.

Mr. CHARYK. The ultimate cost of the high-energy fuel is not a determined factor. It appears that the 5-ton-a-day plants can produce the fuel for the order of $5 a pound. Larger plants using other processes could probably get this cost down to perhaps the order of $2 a pound.

The CHAIRMAN. The plants you referred to cost $44 million. What size plant would you have to have to get it down to $2 a pound?

Mr. CHARYK. Well, actually, the indications had been that in the case of a 10-ton-a-day plant using other processes, that a figure of $2 a pound would probably be able to be realized. We, of course, never proceeded to a plant of that size. Actually, in many respects the 5-ton-a-day plant is, in a sense, a pilot plant for the larger plant which would have been required had the various programs which had considered high-energy fuel gone ahead in a vigorous fashion.

The CHAIRMAN. That would have been a plant that must have cost a half-billion dollars anyway? If this is a pilot plant.

Mr. CHARYK. I have no costs on the 10-ton-a-day plant. I am not sure that we can give precise numbers on this because the details of the process that would be used are really undetermined.

The CHAIRMAN. I read somewhere that one of the fighter planes will be affected by this program. Is that the F–105?

Mr. CHARYK. No. We had no active programs for the utilization of high-energy fuels for fighter aircraft.

The CHAIRMAN. Of course, that is not within the jurisdiction of this committee to develop your weapons. We are interested in the fuel, and that is what we are inquiring about now.

Then as I understand it, the order canceling this program will not affect the B–70 and it won't affect any of your fighter planes?

Mr. CHARYK. It affects the B–70 only through the elimination of the J–93–5 engine.

The CHAIRMAN. You will make a different type engine?

Mr. CHARYK. It is basically the same engine. The difference lies in the afterburner. In one case we are using JP fuels in the afterburner. The –5 engine was to use the high-energy fuels in the afterburner.

The CHAIRMAN. What effort was made at an earlier date to determine the adaptability of those plants to other needs, Mr. Secretary?

Mr. CHARYK. Actually, one of the factors that had influenced our thinking in regard to the type of process that was desirable was that we had hoped that there would be intermediate products in the total process which could have other applications, and in fact the Olin Mathieson plant serves as a means for obtaining decaborane and pentaborane, both of which have potential applications to the problem of rocket propellants.

The CHAIRMAN. We have contracts with the Olin Mathieson Corp. and those contracts are canceled; are they not?

Mr. CHARYK. No, sir. Our action was to request the Air Materiel Command and the Air Research and Development Command to come in with a plan for the orderly shutdown of the 5-ton-a-day plant, and for a critical review of the fuel requirements for the research and development program. They have come in with such a plan and we are in the process of evaluating it at the present time.

The CHAIRMAN. When will you have completed your evaluation?

Mr. CHARYK. I hope in the very near future.

The CHAIRMAN. That is a few days, you mean?

Mr. CHARYK. It may take as long as several weeks.

The CHAIRMAN. Do you have available a plan that you could put in the record here?

Mr. CHARYK. There is no such thing as a single plan. There are a series of alternatives which we are evaluating in order to determine which will be the most efficient from the standpoint of providing our fuel requirements for the research and development program, and which plan will be the most economical.

Mr. MCDONOUGH. Will the gentleman yield at that point?

The CHAIRMAN. I yield to Mr. McDonough.

Mr. MCDONOUGH. Was the 5-ton-a-day boron plant provided for the purpose of furnishing fuel for the B–70?

Mr. CHARYK. The prime requirement for the output from the 5-ton-a-day plant was for the J–93–5 engine for the B–70.

Mr. MCDONOUGH. And now you have converted to hydrocarbons instead of using the boron fuel?

Mr. CHARYK. We intended to use hydrocarbon fuels throughout in the early versions of the B–70, but in the event that it became important to get the required range, one solution was the use of high-energy fuels in the afterburner.

Mr. MCDONOUGH. You abandoned that, however?

Mr. CHARYK. We have abandoned that. And the reason for it is that——

Mr. MCDONOUGH. On what calculation did you determine you would need 5 tons a day?

Mr. CHARYK. Actually, if we were to proceed to equip the programed B–70 fleet with high-energy fuels we would actually require more than the output from the 5-ton-a-day plant.

The CHAIRMAN. Will the gentleman suffer an interruption there?

I will say to the members of the committee, on the floor there is a vote on H.R. 5421, the fishing vessels bill. What is the pleasure of the committee; to adjourn for 15 minutes and vote on it and come back?

If there is no objection, we will recess for 15 minutes.

I am sorry gentlemen, but we can't help it. We have to register a vote.

(Recess taken.)

The CHAIRMAN. The committee will come to order. I am sorry for the interruption. I do not believe we will have any further interruptions this afternoon.

Mr. Secretary, we had some hearings on solid propellants sometime back and in the course of those hearings we were told that boron solid propellants might be available and usable by the large and small missiles.

Is that not right, doctor?

Dr. SHELDON. There was some reference to the borons.

The CHAIRMAN. Has an effort been made to find a use for boron solid propellants in the missile program?

Mr. CHARYK. Yes, sir, we are carrying on a research and development program in a number of companies aimed at the application of boron-type fuels for solid propellant rocket motors as well as for storable liquid propellant systems.

As a matter of fact, the bulk of the fuel requirements for the next year are specifically in connection with the applications to rockets.

The CHAIRMAN. Do the Russians have this sort of situation that we have, where they are now placing emphasis on rocket fuel rather than on airplane fuel?

Mr. CHARYK. I think that in general there is evidence of a concentration of much of the Russian energy in the direction of missiles.

In other words, their aircraft program has not developed to the potential that appeared to be the possibility some years ago. And of course we are familiar with many aspects of their space program and satellite program.

The CHAIRMAN. They, apparently, have made a cutback in their manned bomber programs; have they not?

Mr. CHARYK. This appears to be the indication.

The CHAIRMAN. Which would indicate they are emphasizing the pilotless type vehicle, which would use the rocket type of fuel. That is correct; is it not?

Secretary CHARYK. There definitely appears——

The CHAIRMAN. When did they make that change?

Mr. CHARYK. I beg your pardon?

The CHAIRMAN. When did they make that decision, approximately? Of course I know you are not on the inside of the Russian decisions.

Mr. CHARYK. I think that the greatest evidence perhaps has come from their success in the satellite program and from indications as to the scope of their ballistic missile effort. And this has all been in the last few years.

The CHAIRMAN. Then you would say they made the decision several years ago?

Mr. CHARYK. I would say that they would have had to have made the decision some years before that in order for this to be reflected in an active program in the last few years.

The CHAIRMAN. We are just now reaching the point where we are making the same decision that they made several years ago?

Mr. CHARYK. Actually, our decision to proceed in the ballistic missile area goes back about 5 years now.

The CHAIRMAN. We made this decision 5 years ago?

Mr. CHARYK. Five years ago we decided to have a very intensive effort aimed at the attainment of an intercontinental ballistic missile.

The CHAIRMAN. In the face of that emphasis, as you say, that we decided 5 years ago to place on ballistic missiles, why then were we pushing this program so vigorously and why were we so slow in bringing it to a conclusion?

Mr. CHARYK. Well, 5 years ago our competence in the ballistic missile field was actually pretty low. We decided that it was a matter of urgent national priority to proceed vigorously with an attempt to develop as soon as possible effective intercontinental ballistic missiles. It was very difficult to ascertain at that time how successful our efforts would be. There were a great many people who were extremely skeptical about our ability to produce in a matter of 5 years an intercontinental missile.

There have been very many skeptics as to whether we would be able to achieve the kinds of yields that would make the weapons system attractive and a great many skeptics as to whether we would be able to achieve the kinds of accuracies that would be necessary to make the ballistic missile effective.

The CHAIRMAN. Do you think, also, that the skeptics remained doubtful up until the 1st of August?

Mr. CHARYK. I think we still have skeptics, sir.

The CHAIRMAN. They made a study of this or realized a year or two ago that we had the capability of introducing these intercontinental ballistic missiles.

Mr. CHARYK. I think we still have skeptics, sir.

The CHAIRMAN. So you feel you are not tardy in your decision on building these plants.

Mr. CHARYK. We felt it necessary to protect ourselves in the fields of high-performance, air-breathing vehicles in the event that the ballistic missile did not come along on a timely basis and as assurance against not being able to accomplish all of the things that it is necessary to accomplish to have an effective strategic retaliatory force.

The CHAIRMAN. Well, regardless of that, as a committee we want to help try to work out in any way we can the dilemma that is now presented to you. That is, of having $100 million worth of plants and no work for them to do.

Is there anything that this committee could do to assist you?

Mr. CHARYK. I think that it is still too early to determine the full potential that boron compounds might have insofar as rocket propellants are concerned. This is the reason we feel it is desirable to maintain an active research and development program with this as its objective.

Now, in order to meet the fuel requirements for this research and development program, we cannot begin to utilize the full capacity that is available.

Should, for example, we find that very attractive rocket propellant applications emerge, it could produce quite a different situation.

As a matter of fact, the total capacity that we have in the country at the present time, even with the two 5-ton-a-day plants is really not very large.

For example if the B–70 activity were to be pursued, the total output of the Olin-Mathieson plant would only run the engine for a fraction of an hour. The total output of the plant in 1 day would only run the afterburner for a fraction of an hour.

The CHAIRMAN. So, for your purposes it is not nearly adequate.

Mr. CHARYK. If we were talking about equipping a complete wing of B–70's, we would have had to bring into being considerably more fuel capability, fuel production capability, than is embodied in the two plans that we have been talking about this morning.

The CHAIRMAN. Let me ask you this question. The Navy and the Air Force each built plants and went ahead with their programs.

What efforts have you been making to collate your work and cooperate with the other service?

Mr. CHARYK. Actually, as the testimony this morning indicated, there has been a rather close working relationship between the Air Force and the Navy throughout the entire program. As a matter of fact, the program, of course, originated with the Navy; the Air Force came in at a later date and in the intervening years we have had a rather close working relationship.

The CHAIRMAN. From what has been said it seems to me it is this: that the Navy started the program and then wanted the Air Force to take over part of it and assume a part of the responsibility. The Air Force did take half of it over. The Navy then decided to let the Air Force have it all and the Air Force reneged on it.

Isn't that substantially it?

Mr. CHARYK. Not completely, sir. I would say that the reason for the Air Force's interest was due to the fact that we did see ahead supersonic manned bombers and air-breathing missiles and that this was a very attractive possibility insofar as the achievement of the superior potential that we wanted to have is concerned.

Now, during the last 6 months, of course, we have been approached by the Navy on a couple of occasions in regard to the Muskogee plant and we have indicated on both occasions that our present requirements are not such as to justify participation on our part in the Muskogee plant.

The CHAIRMAN. Had both Departments not engaged in the same program, of course, our losses would have been smaller; would they not?

Mr. CHARYK. Actually I should perhaps indicate that the fuel produced in the two plants is not the same.

The CHAIRMAN. What is the difference? That is what I am getting at.

Mr. CHARYK. Well, actually, the product of the Muskogee plant is a fuel which is referred to as HiCal–3.

From the Air Force's point of view, some of the physical properties of the HiCal–3 are not as attractive as the fuel that is being produced by the Olin Mathieson Co.

In particular, these physical products are critical in the case of high-temperature applications such as would be associated with aerodynamic vehicles flying at supersonic speeds, such as the B–70, for example, or the Bomarc missile.

Now, modifications can be introduced that would permit HiCal–3 to be modified in such a way as to improve the physical properties but this would require plant modifications and extra cost to accomplish.

As I also indicated this morning, we were interested in having as some of the products along the way, shall we say, materials which had potential applications in the rocket propellant field. And there again the Olin Mathieson process is somewhat more adaptable to the attainment of materials along the way which have potential rocket applications.

The CHAIRMAN. If then there is to be an abandonment of any of the plants, from what you say, it is preferable from an Air Force viewpoint that the plants in New York be the ones retained?

Mr. CHARYK. This is one of the things we are studying at the present time. We are trying to get better information on the modifications that would be necessary in the case of the Muskogee facility, in order to produce the type of products in which we would be interested.

The CHAIRMAN. Let me ask you one more question and then I am going to turn you over to the others on the committee.

What contracts do you have with what universities and what colleges and what private institutions to pursue this same program?

Mr. CHARYK. Actually we have a——

The CHAIRMAN. And what is the amount of them?

Mr. CHARYK. We have a variety of contracts. I might just cite some of the more important ones.

We have contracts with the Reaction Motors Division of Thiokol Chemical, with Olin Mathieson, and with the U.S. Borax Corp. aimed at the exploitation of boron compounds for high energy solid propellants.

We have contracts with Rocketdyne Division of North American Aviation and with the Aerojet General Corp. aimed at storable liquid propellant rocket systems.

The CHAIRMAN. Is that boron?

Mr. CHARYK. Boron type compounds, yes.

We also have contracts with a combination of Aerojet General and Stauffer, with Callery and with a combination of American Potash, Food Machinery, National Distillers, and also with Olin Mathieson in regard to process studies for the production of boron type fuel.

The CHAIRMAN. How about the universities and colleges; do you have contracts with them?

Mr. CHARYK. I am not familiar in detail with these contracts.

The CHAIRMAN. Do you have the list there?

Mr. CHARYK. We do not have a list with us, sir.

The CHAIRMAN. Mr. Secretary, are those contracts all being canceled, too?

Mr. CHARYK. No, sir; but they are the contracts which are under review at the present time in connection with our review of the overall situation in regard to boron fuels.

The CHAIRMAN. Are those contracts included in the $120 million expenditures?

Mr. CHARYK. Yes, sir.

The CHAIRMAN. They are part of the $120 million?

Mr. CHARYK. Yes, sir.

The CHAIRMAN. If they are canceled is there an obligation on the part of the Government to indemnify anybody?

Mr. CHARYK. There would certainly be termination costs in the majority of these contracts.

The CHAIRMAN. When are you going to get around to that? If the plants are useless and the program apparently has been condemned, is there any need to continue with those contracts and hadn't we better face the facts there?

Mr. CHARYK. Well I indicated we do have an active interest in the exploitation of boron type fuels for rocket applications and in order to pursue this program we do have a fuel requirement for the next year.

The purpose of the study at the present time is to determine the most efficient and economical fashion in which to obtain the specific products in which we are interested.

The production capability which exists is far in excess of these requirements and we do want to select the most economical method for obtaining the materials that we do need for the research and development program. We clearly have a multiple choice in view of the capability which exists and in view of the comparative requirements.

The CHAIRMAN. So that the contracts are now being reviewed for cancellation.

Mr. CHARYK. Some of the contracts will certainly be continued and others will be terminated.

The CHAIRMAN. Mr. Karth, do you have any questions?

Mr. KARTH. Mr. Secretary, these ZIP plants were built for the purpose of supplying fuel for the R. & D., to be done on the J–93 engine.

Mr. CHARYK. That was one of the major applications.

Mr. KARTH. What was the other?

Mr. CHARYK. There was the possibility of an improved Bomarc program aimed at the extension of the ranges of the Bomarc. This program has not materialized. This would have also been a user of fuel of this type.

Mr. KARTH. When did you determine that the Bomarc would not be a user of these fuels?

Mr. CHARYK. This has been a matter that has been under study for some time. It has never been an active program although we have carried on a certain amount of research and development to determine what the problems would be in such an application. And I indicated this morning, for example, that we have actually flown a Marquardt ramjet engine applying this type of fuel successfully.

Mr. KARTH. In a Bomarc?

Mr. CHARYK. This would be an engine for an advanced Bomarc.

Mr. KARTH. Although you did have some plans, did these plans play any major part in the facilities to provide ZIP—this exotic fuel?

Mr. CHARYK. The main interest in having a fuel capacity of the type indicated was to permit the engine development program that would be necessary for the application to the B–70.

Mr. KARTH. That was the major concern in building the ZIP plants?

Mr. CHARYK. Insofar as the Air Force was concerned.

Mr. KARTH. If this engine had proved its worth, rather than not serving the purpose for which it was intended would you then have had enough capacity? Or would you have had too much under even those conditions?

Mr. CHARYK. Actually if we had gone ahead with the use of high energy fuels in the B–70 application, we would have had a need for a considerable augmentation of our fuel production capabilities.

Mr. KARTH. Are you building plants for the purpose of providing a supply for R. & D. and not for the whole Air Force?

Mr. CHARYK. For the engine development for the B–70. To qualify the engine.

Mr. KARTH. If you were going to provide a fuel supply for a whole wing of aircraft, then, of course, your supply would have been entirely inadequate?

Mr. CHARYK. That is right.

Mr. KARTH. But these plants that are built were to supply fuel for the R. & D. of the engine, is that correct?

Mr. CHARYK. That is correct.

Mr. KARTH. Even insofar as that is concerned, what is your total capacity?

Mr. CHARYK. For the research and development effort?

Mr. KARTH. Yes.

Mr. CHARYK. We have an eight-tenths-a-ton-day plant at Olin Mathieson, and a 400-pound-a-day plant at Olin Mathieson and we have a 250-pound-a-day facility at Callery, at Lawrence, Kans.

Mr. KARTH. You said on page 3, Mr. Secretary, "A decision was made to terminate the development of the J–93–5 engine." Would you care to tell us when that decision was made?

Mr. CHARYK. This decision was made in the last few weeks and——

Mr. KARTH. Very recently.

Mr. CHARYK. Very recently, and simultaneously with that action, we took the steps to bring about an orderly shutdown of the 5-ton-a-day plant because it was perfectly clear that if the J–93–5 engine was not to be continued, there would be no use for the output of the 5-ton-a-day plant, so these actions were taken essentially simultaneously.

Mr. KARTH. Of the $121 or $122 million that the Air Force spent, how much went into the J–93–5 engine other than the fuel?

Mr. CHARYK. $8.7 million.

Mr. KARTH. Is there any possibility of using these engines or those things you have developed toward the engine—is there any possibility of using this for any other engine or anything else of value, Mr. Secretary?

Mr. CHARYK. I should emphasize that the J–93–5 version simply refers to the use of high energy fuel in the afterburner. The engine that will power the B–70 and also the 108 is the J–93–3 engine. That program, of course, is continuing, so that the $8.7 million that I referred to has primarily been expended toward the development of

an afterburner for the J–93 engine that could utilize the high energy fuels.

The conventional afterburner will utilize JP fuels.

Mr. KARTH. So you will not be able to convert this to any useful purpose, I suppose?

Mr. CHARYK. Well, I think the experience would certainly be useful in application to ramjet engines in the event there should evolve a requirement for a supersonic ramjet engine. The experience would be directly applicable.

Mr. KARTH. There wouldn't be a total loss in that field, would there?

Mr. CHARYK. Not at all.

The CHAIRMAN. Are there any further questions?

Mr. WOLF. It says:

Further, the advance Bomarc, which was another potential user of boron fuels, has not become an active program.

I suppose the reason the Bomarc got the appropriation was because it was to be the great salvation of the cities in America.

Is this just regarding this particular fuel or is the Bomarc program dead, as we were told?

Mr. CHARYK. We have never had a formally approved advanced Bomarc.

Mr. WOLF. This was the one they made their debate on, on the floor.

Mr. CHARYK. No; that was the Bomarc B. The B employs JP-type fuels. I am referring to an improvement beyond the Bomarc B, where high-energy fuels would be used in the ramjet engine.

This program has never been an approved program.

Mr. WOLF. This is the thing I wanted to clarify because I knew all the time in the debate on the floor they weren't talking about an existing weapon; they were talking about Bomarc A, but they were doing all this talking on the B, which too does not exist.

Mr. CHARYK. And my reference here is to something beyond that.

Mr. WOLF. That is what I wanted to establish.

Thank you, Mr. Chairman.

The CHAIRMAN. Does that throw out this program?

Mr. CHARYK. The program is not an active program and has never been approved.

The CHAIRMAN. It will never be approved now under this?

Mr. CHARYK. I would say the probability is not very high, sir.

Mr. WOLF. Does this mean the Bomarc B will phase out, too, very shortly?

Mr. CHARYK. The Bomarc B program will continue on the basis as proposed in the master air defense plan.

Mr. WOLF. Just looking ahead for the next 2 or 3 years?

Mr. CHARYK. Most of the Bomarcs making up the master air defense program are of the B variety.

Mr. WOLF. But they are not on site now?

Mr. CHARYK. That is right.

Mr. WOLF. That is what worries me. This weapon which is supposed to save us in the immediate future is not on target. Now, we are to phase out the advance program, which you say will never be

developed now, and the program that is obsolete is our on-target defense.

You might naturally know I don't like the Bomarc program very well.

The CHAIRMAN. It throws us back, then, to the Nike program, doesn't it?

Mr. HECHLER. This morning you showed some figures showing Air Force expenditures through fiscal year 1959 totaled $120.2 million.

I wondered if you could give us an estimate of fiscal 1960 expenditures.

Mr. CHARYK. Our estimate of the expenditures in the R. & D. area relating to boron-type fuels is of the order of $5 million.

Mr. HECHLER. Now, how much of those expenditures are expenditures between the end of fiscal year 1959 and the present? What I am getting at is, how quickly are you able to reduce expenditures in the ensuing months of fiscal year 1960?

Mr. CHARYK. Actually, the $5 million figure that I indicated was primarily aimed at the application of boron-type fuels to rocket applications, so we still have quite an active interest in that.

Mr. HECHLER. I am concerned about the phrase you use "orderly shutdown." None of us are in favor of disorderly shutdown, surely. Yet there is a slight inference there, and also an inference in your prepared statement here, that perhaps you have been moving forward cautiously to close this operation down, and you say, "We have asked our technical staffs for a plan for the orderly shutdown," and I just wanted to indicate that there are many of us who would like to inject a note of urgency when there is a possibility of saving any money.

I refer to the same type of urgency with which we move forward toward a new and constructive development, and I have a feeling that all too frequently the Department of Defense doesn't have that sense of urgency when it has a possibility of saving some money, and here I think we have effectively demonstrated the necessity of shutting down the 5-ton-per-day plant quickly. I would not even object to precipitous shutdown. I wouldn't want you to be disruptive, but I had a feeling you might not be pursuing this with such speed as——

Mr. CHARYK. No; I didn't want to leave that impression. I am equally anxious to effect all the economies that can be effected.

The problem, however, is not a very simple one in that there are, for example, raw materials which are in the plant at the present time. The disposal of these materials presents a rather severe problem, and we are trying to explore the best methods to bring about the shutdown of the plant, but we just can't close the doors.

Mr. HECHLER. In other words, your decision about the speed is not related in any sense to the amount of your past investment?

Mr. CHARYK. No.

Mr. HECKLER. That is all.

The CHAIRMAN. Mr. Moeller——

Mr. MOELLER. Mr. Secretary, this can't, of course, all be lost and all wasted. What percent of this expenditure would you say might justly be charged against some future R. & D. program? In other words, could you say we have learned something from this that would cut down a future R. & D. cost, say, 25 or 50 percent?

I am trying to see a little ray of light here, indicating that not all is so bad.

Mr. CHARYK. That is a very difficult question to answer, and I guess the answer really depends on what happens in the future.

For example, should there emerge, let us say, a very attractive application of boron-type fuels to rocket motors, the requirements could far exceed the capabilities that we have in existence at the present time.

If, for example, the research and development program aimed at rocket propellants is unsuccessful, then we will have the situation where we will have greater capacity than requirements.

The information that we have learned in regard to boron chemistry, boron hydrides, could have application in the solid rocket propellent field, the liquid rocket propellent field, and if any future ramjet requirements evolve, it could also have important application there.

So I think that only the future can really tell what money has been profitably spent and what money we could have avoided spending.

Actually, hindsight is a lot easier than foresight, but it would be difficult for me to hazard a guess as to what our future requirements would be.

Mr. MOELLER. I didn't suppose you could give us an accurate answer on this, but I have the hope that there is some good coming out of this thing, wherein we are going to save ourselves several hundred thousand dollars in the future perhaps.

Mr. CHARYK. I think the experience that has been gained and the knowledge that has been gained about fundamental combustion processes can have applications in a lot of different fields.

The CHAIRMAN. Mr. King——

Mr. KING. Mr. Secretary, looking at this as a layman, which I am, this thing impresses me. It seems to me an unduly long amount of time was taken before the error was discovered.

We all know you can take a wrong turn in traveling down a road. We have all had the experience of traveling in our car and taking the wrong road, but usually we catch the error relatively quickly. When we go on 200 or 300 miles without detecting the error, then the question immediately comes up, "Why wasn't the error detected sooner?"

As I understand the testimony, the thing that caused the Navy and the Air Force to change its mind on this particular program was, first, technical deficiencies in the program—namely, the toxicity, plus the fact that there was a residue that gummed up the blades or something. In any event, there were technical deficiencies, plus the fact there was a deemphasis on the use of fuels for jets in favor of emphasis on fuels for rockets, missiles, and so on. That is, as I gather, the substance of the testimony.

My question is, Why couldn't these things have been anticipated a little sooner? For example, on the technical deficiencies, those are things that it seems to me could have been threshed out in a test laboratory before this very elaborate expenditure had been made.

And then on this matter of deemphasis on the one type of fuel in favor of the other type of fuel, that, in turn, was the result of forces that were reasonably foreseen many years ago.

We certainly have been beefing up our rocket program for the last 4, 5, or 6 years, and it just seems a little incredible to me that just within the last 2 or 3 weeks suddenly we decide to make this change in policy that could have been foreseen, it would seem to me, 2, 3, or 4 years ago.

So my question is, Why did it take so long before this error was seen and a reverse in course was indicated?

Mr. CHARYK. Well, I don't think the picture is really quite that black. The triggering factor, as I indicated earlier, was the decision not to use high-energy fuels in the B–70 application, that is, in the afterburner of the B–70.

The reason for the decision not to use high-energy fuels is related to the fact that we have been able to achieve over the last 6 months considerable improvement in the potential performance of the B–70 by means related primarily to structures and aerodynamics.

We now have high confidence that the range requirements for the B–70 can be met without the use of high-energy fuel in the afterburner. The answer could have been otherwise. We could have found that it was essential to use high-energy fuel in the afterburner to meet the range requirements.

Mr. KING. You are saying that technological progress in other related areas has also united to make unnecessary the use of exotic fuels?

Mr. CHARYK. And very recently. Within the last few months.

So, looking at the situation anew, when it became clear we could meet the range requirements without the need for high-energy fuel, we took immediate steps to cancel the J–93–5 engine and simultaneously to take actions to close down the plant.

Had the technical developments proceeded in another direction—that is, suppose we had been unable to meet the range requirements except by the use of high-energy fuels, we would have had a requirement at that point for all of the capacity that we have in the country for high-energy fuels.

So, I think the decision is a timely one, and it is not true that the situation was clear many years ago.

I would just like to reemphasize that it has only been within recent months that we have come to the point where we have a high confidence in meeting the performance requirements for the B–70 without high-energy fuels.

Mr. KING. Would you have continued with this program if it had not been for the developments that you just mentioned a moment ago?

Mr. CHARYK. Had it not been for the B–70 requirement, I feel sure this action would have been taken some time ago.

The CHAIRMAN. Mr. Roush.

Mr. ROUSH. No questions, Mr. Chairman.

The CHAIRMAN. Mr. Hall.

Mr. HALL. No questions.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. I have been looking this thing over a little bit, and I would like to ask this.

We have two 5-ton capacity plants recommended. And the question then was about whether to go ahead and build them.

Now according to Rear Adm. Robert E. Dixon, Chief of the Bureau of Aeronautics, in his statement on page 3:

> In June of 1959, the Chief of the Bureau of Aeronautics recommended termination of the Muskogee production contract and requested the concurrence of the Chief of Naval Operations.

And then on page 4, he says:

At present, the Navy-owned Muskogee plant is in a standby status capable of restart up within 6 to 9 months.

Above, in his statement on page 4, the admiral states:

In June of 1959, the Director of Defense, Research and Engineering, initiated a comparative study by A. D. Little & Co., Inc., of the two 5-ton-a-day high-energy fuel plants that were to begin production August 1959. This study was to determine which plant would be the most economical and technically sound to operate if only one of the two plants were to operate.

From what you say, obviously only one of the two plants could operate, not even one plant could operate.

Then the admiral says:

When the Air Force requirements for a 5-ton-a-day plant were recently removed, the Navy had no alternative but to terminate. Since Navy requirements had previously been drastically reduced.

Now, it would therefore seem to me that the Navy has acted within this area of reference, promptly. Because at present the Navy-owned Muskogee plant is in a standby status. So that from the time the Director of Defense, Research, and Enginering, initiated a study in June 1959 to see which of these plants was most economical and should be continued in operation, one has already been shut down.

Now, the rather remarkable thing about that is that the plant that has been shut down in these 5-ton-a-day high-energy fuel capacity plants has 450 employees, and costs, according to the Navy's statement here, $35 million, and the plant being run has 750 employees, and, as I understand, it cost around $45 million.

On the face of it, it would seem to me that, with action taken like that, it lies almost in the face of proper economy, because I could hardly imagine a plant operating with 750 employees at a cost of $45 million, when a plant with 450 employees, costing $35 million, is promptly shut down and held on a standby status.

Why are you continuing operation of the one plant with 750 employees while the Navy, in 60 days, has promptly shut theirs down?

If it is right in one case, why is it not right in an exactly similar case in another agency of the Government?

Now, will you explain that to me?

Mr. CHARYK. Well, I might first of all reiterate——

Mr. FULTON. Don't reiterate. Why does it take you so long to make up your mind when the Navy has already made its decision?

Mr. CHARYK. I think one difference is that we have a continuing requirement for fuel for our research and development program.

It is my understanding that the Navy has no further requirements for high-energy fuels.

Mr. FULTON. Well, you don't have any requirement above eight-tenths-of-a-ton-per-day capacity, as I understand.

Mr. CHARYK. It is possible that we can obtain all of the fuel that we need by operating the 0.8-ton-a-day plant.

Mr. FULTON. Why is one plant shut down while the other isn't, while this decision is being made by the Little Co.?

Mr. CHARYK. We want to be sure our actions in shutting down the plant are consistent with our fuel requirements and represent the most economical fashion in which to achieve these fuel requirements.

Mr. FULTON. Why didn't the two of you, the Navy and the Air Force get together and find which was the most economical plant, quickly?

It would seem to me that by shutting one down and then have the A.D. Little Co. make a survey to see which one should be kept open, is not economical—and I happen to be a businessman myself.

Mr. CHARYK. We are still looking for the best way to obtain the fuel requirements that we have, and we are including the Callery plant in these considerations.

The CHAIRMAN. The Secretary testified earlier that there was a difference in the end product. One makes a different type of product.

Mr. CHARYK. Yes, I indicated that the Olin Mathieson product as it is set up produces directly the materials that we need for our research and development effort in the rocket propellant area. The Callery plant does not produce these materials directly. It is possible that the process could be modified to produce such materials. We do not have, at this time, a figure for the modification costs.

Mr. FULTON. Have each of them been asked to supply that figure to you promptly? Have you asked both Callery and Olin Mathieson Co. to come up with a figure?

Mr. CHARYK. We have taken steps to obtain the information.

Mr. FULTON. What do you mean by that?

Mr. CHARYK. The information is being obtained actually from various sources.

Mr. FULTON. Well, just ask the companies. Have they been asked yet.

Mr. CHARYK. I am not sure whether a formal request has been made——

Mr. FULTON. I would certainly get one out in a heck of a hurry.

You are operating one plant with 750 people a day, at the cost of the taxpayers, and you have the other one shut down, employing 450 people a day. I think before you have to go through the cost of reestablishing a plant you had better make sure before you terminate and cut down in one department while the other department is making up its mind.

Mr. CHARYK. Well, the purpose in our review of the situation is to determine the most economical fashion in which to obtain the fuel for our research and development requirements.

The Navy action, in taking the steps they did at Callery, was done for reasons best known to themselves, I would say.

Mr. FULTON. Yes, but that is my point. There seems to be a lack of cooperation between the Navy and the Air Force at a certain point. When looking at it as an overall Government and taxpayer matter, one takes one without correlation with the other and there does not seem to be any direct action to find out what the costs are by inquiring of the companies.

Why don't you have them submit a bid right away?

Mr. CHARYK. I believe that the Navy did request from the Callery Co. certain information regarding various shutdown operations and partial operations.

Mr. FULTON. Have you specifically asked both companies to submit you a bid on your requirements, and if so when did you do it and within what time did they reply? Have you done that?

Mr. CHARYK. We have an understanding with the director of the——

Mr. FULTON. Just answer my question, if you will, please.

Mr. CHARYK. The problem is not limited to the Air Force.

Mr. FULTON. That is what the trouble is. Your requirements are limited to the Air Force.

Mr. CHARYK. That is right.

Mr. FULTON. And the question is, Have you asked them for a bid. If so, will you please submit it for the record?

Mr. CHARYK. Actually, the matter really comes under the province of the Director of Defense Research and Engineering, since it involves both the Air Force and the Navy. We are in complete understanding with the Department of Defense as to how the evaluation will be made.

Mr. FULTON. Sure, but have you asked these companies for a bid?

Mr. CHARYK. I do not know whether the Department of Defense has specifically asked Callery or not.

The CHAIRMAN. Let us do this, to terminate it and save time. Why not ask the Secretary to give us that answer after he has had a chance to investigate it.

Mr. MILLER. Why not ask the Director of Defense Research and Engineering who is the top man, to come before the committee?

The CHAIRMAN. Fine.

Mr. MILLER. I imagine we could put these questions to him.

I think that you are on a very hot line, Mr. Fulton, and I would like to see it pursued.

The CHAIRMAN. If we do not get it before then, we will ask the Secretary of Defense to appear.

Mr. FULTON. I do not call it a hot line. I am inquiring for facts and I would imagine that the Secretary of the Defense would know, whether or not, for his own information, there had been a bid put out to several companies to see which was the lowest bid.

Now, I would guess that.

During World War II I was on the aircraft scheduling unit scheduling plane production and I am not an amateur at this.

Mr. MILLER. One of the reasons we went into unification was to take care of these things and we have this Director of Defense Research and Engineering who receives this information. I would like to ask the Director of Defense Research and Engineering "Is it cheaper to produce this fuel at the Muskogee Government-owned plant."

Mr. FULTON. Well, let us put some bids out and see who is going to be the low bidder and not keep plants running with 750 employees a day.

The CHAIRMAN. While we are on that subject, Mr. Secretary, I would like to know when you are going to get around to canceling these contracts that are continuing on, and why no immediate effort is being made to cancel those that are not needed.

Mr. CHARYK. I hope that this can be done very promptly.

As I said earlier, we have been in close contact with the Director of Defense Research and Engineering. He has asked for the kind of information that we need to make the best decision here. As far as the Air Force is concerned, we have provided him with most of this information. We are providing additional information.

He has made inquiries of other companies—for example, the A. D. Little Co., who has been conducting the study that was referred to earlier and they have been asked for certain information.

When this information is available in his office, I am sure that a prompt decision can be made.

The CHAIRMAN. Well, ask the Defense Department for these unanswered questions.

Mr. FULTON. Why don't you put out bids to see who will supply this requirement of yours for high energy boron fuel for the next period, at the lowest price?

Why don't you immediately do that in the Air Force in conjunction with the Navy?

Why don't you do it now?

That will cut the Gordian knot and it will permit us to see who does supply it cheapest.

The CHAIRMAN. I think Mr. Miller is right, the Secretary of Defense——

Mr. FULTON. If you would just let him answer that question, I would appreciate it. It is my question, not yours, Mr. Chairman, or Mr. Miller.

The CHAIRMAN. The trouble is—I know it is your question—but it is the same question that has been asked him 15 times, and I am just trying to save time on the part of the committee.

Mr. Secretary, if you can answer that, will you do so?

Mr. CHARYK. I will take another try at it.

The materials that we primarily need for our research and development program are directly obtained from the process used by the Olin Mathieson Corp.

They can probably be obtained from the Callery process with additional funds required for modifications.

It is my understanding, from the Director of Defense Research and Engineering, that this information is being obtained. When this information is available in his office, I am sure that a prompt decision can be made as to the best and most economical course to follow.

Mr. FULTON. That does not answer the question.

The CHAIRMAN. Let us do this: We will get the Defense Department later and secure their answers.

I can see, for instance, where the Secretary could not commit the Navy for the operation of a Navy plant.

Although, frankly, there is one thing that disturbs me in the lack of operation of our Defense Department, that there is not the coordination and cooperation sometimes that should be seen.

Mr. FULTON. Could I just make a comment as we close?

There must be some way in the Department of Defense, by bids or otherwise, to determine what supplier will supply the quantities needed for R. & D., on boron high energy fuel, and it should be by cooperation among the various services and it should be by competitive bid, where it has already had a research and development job done on it so we know what we want in the Government.

If that is possible, the question is, Why hasn't it been done?

The CHAIRMAN. Thank you very much, Mr. Secretary, you and those who supported you here. We appreciate your time and attention and your testimony.

Now we have one more witness this afternoon, Dr. Emerson Conlon, Assistant Secretary, Aeronautics and Space Research of NASA.

Dr. Conlon, do you have a prepared statement?

Mr. CONLON. I do.

The CHAIRMAN. Dr. Conlon is the Assistant Director of Aeronautical and Space Research for powerplants for NASA, and he has a responsibility for research on propulsion problems and energy generation for applications in both aeronautics and space. He has a long line of achievements behind him. I know he is very proud of them. I will not take the time, however, to read them at this time. Doctor, you have a prepared statement, and if you will proceed with it, we will be glad to hear it.

Mr. CONLON. First, let me correct the record. I do not have a doctor's degree. Somehow I got awarded an honorary one there. Just make it "mister."

The CHAIRMAN. We are making you a doctor this afternoon.

Mr. CONLON. Thank you, sir.

STATEMENT OF EMERSON CONLON, ASSISTANT DIRECTOR, AERONAUTICS AND SPACE RESEARCH OF NASA

1. The NACA research on the application of boron fuels to jet-propelled aircraft was initiated about 1946. The 40-percent increase in the heat content—B.t.u. per pound of boron fuels as compared with conventional fuel offered obvious advantages of increased power for jet powerplants. In the period from 1950 to 1959 the NACA devoted about 26 percent of its research effort on boron fuels to exploration of chemical synthesis of the fuel, and determination of thermal and physical properties; 17 percent to basic combustion research and that is flame speed, ignition and the mechanism by which the oxide was deposited; and 57 percent to the problems of making the boron fuel operate satisfactorily in turbojets, afterburners and ramjets. A total of about $3,500,000 was spent on this research.

2. The following major problems developed when tests on boron fuels in jet engines were initiated.

(*a*) Fuel injection: Boron fuels decomposed at high temperatures and tended to form a solid before complete burning. This problem was solved by designing fuel injection nozzles which mixed air with the boron fuel, thereby obtaining rapid burning. These injection nozzles were used in all subsequent tests.

(*b*) Fouling of engine: The products of combustion of boron fuels (boric oxide) become a liquid below about 3,000° F. As the temperature decreases this liquid becomes like glue and adheres to the various parts of the engine, and at about 850° F. it becomes a solid. The formation of this deposit on the turbine was similar to the formation of ice on the wing of an airplane. The first test demonstrated that a turbojet engine would lose power rapidly after a short period of operation. Research on component parts demonstrated that this problem could be solved by increasing the temperature of the engine and making certain other modifications. However, considerable work remains to be done and full-scale engine tests over a wide range of operating conditions would have to be done to obtain a satisfactory tur-

bojet for boron fuels. The problems of using boron fuels in afterburners and ramjets were much easier to solve.

(*c*) Loss of power at high temperature: Experiments on a full-scale afterburner indicated that if the operating temperature was raised from 2,500° F. to 3,000° F., a 10- to 12-percent loss of energy was encountered. At 3,000° F. the boric oxide did not condense while passing through the nozzle and the energy corresponding to the heat of vaporization was lost. Modification of design of the nozzle tended to minimize this problem.

(*d*) Fuel handling and thermal decomposition: The boron fuels are toxic and are subject to decomposition at elevated temperatures. As a result of considerable research by several agencies, including the NACA, solutions were found to these problems, and data necessary for designing satisfactory fuel systems for aircraft were obtained. Results from the research program demonstrated that satisfactory ramjets and afterburners can be developed.

3. During the past 2 years the boron fuel research program has included the modification of a J–47 turbojet engine to incorporate changes which previous research indicated necessary for satisfactory operation on boron fuels. This engine has been designated the "hotrod engine." The modifications include:

(*a*) Higher operating temperature.

(*b*) Reshaping of turbine and stator blades to minimize the deposit of the products of combustion.

(*c*) Lower velocities in the exhaust gas leaving the turbine.

The parts for the "hotrod engine" have been fabricated, tested, and redesigned, but the final configuration of the engine has not been tested.

In the first configuration it performed reasonably well but there were still too much deposits and another modification was made.

At the request of the military services, the NASA has supported their boron fuel program by direct consultation services to their project officers and to their contractors. Direct experimental support has also been given to the General Electric J–93–5 engine program.

When the Department of Defense announced cancellation of the boron fuel production program and the J–93–5 engine, the above-described research was terminated.

4. Rather recently the NASA initiated research on boron hydrides as fuels for rocket motors. Boron will combine with nitrogen in somewhat the same manner as hydrogen will unite with oxygen. Thus boron hydrides are of interest as rocket propellants. This fuel is more powerful than some conventional rocket fuels such as oxygen-hydrocarbon, and more stable than the most powerful rocket propellants such as liquid hydrogen and oxygen or hydrogen and fluorine. Consequently, for long-duration missions and other uses where stability is important the boron compounds offer promise. All the fuels, including the boron hydrides, have disadvantages.

However, the relative importance of these disadvantages is dependent upon many factors in the overall vehicle and the mission for which it is intended. Therefore, in order to make the most intelligent decision on the choice of a fuel-oxidizer combination for an engine to be developed, it is necessary to obtain the basic research and engineering knowledge on several of the more promising combinations. Research is now underway on boron hydrides as rocket propellants.

5. The amount of boron fuel used by the NASA in these research programs is small and therefore the NASA has no requirement for the two boron fuel plants which the Department of Defense is closing.

The CHAIRMAN. I think your last sentence there, No. 5, sums up your full statement. It is what I was going to ask.

Are you familiar with these plants around Buffalo and the one plant in Oklahoma?

Mr. CONLON. No, I am familiar with the amount of fuel which they will produce and that greatly exceeds that fuel which we would use in our research.

The CHAIRMAN. Have you made any inspection of those plants to see whether or not they would be serviceable to NASA?

Mr. CONLON. No, sir.

The CHAIRMAN. Have you made any effort to determine whether or not they are adaptable to any of the work of NASA?

Mr. CONLON. No, sir, we have not, to the best of my knowledge.

The CHAIRMAN. Have you been requested by the departments to make such a survey?

Mr. CONLON. Not to my knowledge.

The CHAIRMAN. You know the plants are going to be placed apparently in standby. In fact, one of them has already been placed in standby and the other large plant is about to be placed in standby. The smaller plants, as I understand it, now are in standby condition.

Now, no effort has been made to interest you in the possibility that NASA may need those plants, or an adaptation of those plants for the NASA program?

Mr. CONLON. No, sir, as far as I can see no one has envisioned anything in those plants which would be adaptable to our research programs.

The CHAIRMAN. Are you speaking for NASA now?

Mr. CONLON. NASA, yes, sir.

The CHAIRMAN. Nobody in NASA has visualized any possibility that those plants might be usable by NASA?

Mr. CONLON. I have not heard of the idea.

The CHAIRMAN. What would you say as to the future possibilities of boron solid propellants for missiles and space vehicles?

Mr. CONLON. I would like to put it this way: We have fuels at one energy level now—hydrocarbons and oxygens. Boron fuels come in with a higher impulse. Then we have fuels with even higher impulse than the boron fuels. We are investigating all of these fuels. There are not enough facts known now to say which ones will be most useful and which missions they will be used for.

It is a very complex problem as you can see.

The CHAIRMAN. The boron fuel is in the middle between the two extremes, right?

Mr. CONLON. Yes.

The CHAIRMAN. You would not hazard any statement as to the possible future of boron solid propellants for either aeronautics or astronautics?

Mr. CONLON. It has possibilities, sir. Let me put it this way. The use of boron fuels in rocket motors is rather recent and the investigations have been initiated rather recently, particularly on some of the newer compounds. We have not enough information to make an intelligent decision at this time.

The CHAIRMAN. Well, we have spent $243 million over a 7-year period of time. That is not too recent, is it, even in scientific programs?

Mr. CONLON. That was boron fuels for air-breathing powerplants. Not boron fuels for rocket motors.

The CHAIRMAN. What would be the difference between rocket boron and air-breathing boron?

Mr. CONLON. Let me consult—we are very close to classified material.

There is a difference in the boron compound which would be used for the rocket motor and that which would be used for the air-breathing engine.

The CHAIRMAN. What is the difference between the Muskogee, Okla., plant and the one in New York?

Mr. CONLON. The boron compounds are different but both suitable for air-breathing engines.

The CHAIRMAN. In other words, you would need a different type of boron propellant for rockets than what you have in either one of the other plants?

Mr. CONLON. It is quite likely.

The CHAIRMAN. So the contention by the services to the effect that their propellant might be usable in rockets would really fall flat, would it not?

Mr. CONLON. I believe satisfactory modifications to either plant could be made.

The CHAIRMAN. Is it major or minor modification?

Mr. CONLON. That I wouldn't know, sir.

The CHAIRMAN. Well, you know it is a very serious thing to a community to be faced with the possibility that a plant which is just completed and costs $35 million to $45 million is about to be put in a standby shape with no immediate future. It would seem to me that knowing how serious that is, not only to the exchequer of the U.S. Government in a loss of that amount of money, but also to a community, that that would receive early attention by those who might find a use for those plants.

Mr. CONLON. You have coming here tomorrow a representative from Callery and I think he has those figures and can give you much better figures than I could.

The CHAIRMAN. We have a representative from Callery and also a representative from the other company, Olin Mathieson.

Mr. CONLON. Both of those companies are familiar with the possibilities of using boron for rocket motors.

The CHAIRMAN. We have the vice president of Olin Mathieson tomorrow, also.

Mr. CONLON. I would rather have that information on plant modification to come from him than me.

The CHAIRMAN. They are more familiar with the plants?

Mr. CONLON. Yes.

The CHAIRMAN. At this time then, NASA has no foreseeable use for any of this property?

Mr. CONLON. That is right, sir.

The CHAIRMAN. Questions?

Mr. MILLER. No questions.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. Your statement is startling, Mr. Conlon, in one respect. You say that the National Advisory Committee for Aeronautics spent a total of about $3,500,000 on this research of making boron fuel operate satisfactorily in turbojets, afterburners, and ramjets. As a matter of fact 57 percent of that was used for that purpose. That is an entirely different order of magnitude than the amounts we are talking about here otherwise.

How does it come that you people in NASA, that has taken over NACA's functions, have operated your research on such a small amount in the same field while the two services have been going into it on a giant basis? What is the difference?

Mr. CONLON. We work in relatively small-size experiments, initially. Components of the engines and small engines and it does not become expensive until you move into full-scale engines and, of course, construction of plants to produce large amounts of fuel.

Mr. FULTON. And you said:

> The first test would indicate the engine would lose power rapidly because of the boric oxide that was formed.

Mr. CONLON. Right.

Mr. FULTON. You went slow and kept it on a rather narrow research and development program at that point.

Mr. CONLON. Yes, but we also progressed, we thought as rapidly as needed to meet the military requirements. We felt rather confident that the problems with the engine could be solved.

Mr. HECHLER. Will the gentleman yield for a brief question?

Mr. FULTON. I will be glad to, yes.

Mr. HECHLER. Don't you think it is possible to obtain conclusions on the feasibility of use of this type of fuel without the construction of plants?

Mr. CONLON. Yes. Let me make that clear. I believe and the NASA believes that you can make ramjets, afterburners, and turbojets operate satisfactorily on boron fuel, if there is a requirement to do so.

Mr. HECHLER. I don't think you quite understood my question, which was whether you could complete this research without the construction of actual plants for the production.

Mr. CONLON. Yes, you can complete that much of the research and we went far enough to convince ourselves that it could be done.

The CHAIRMAN. But you also got far enough to convince yourselves it was not practical at this time to go ahead, didn't you?

Mr. CONLON. No, sir.

The problems can be solved.

Mr. FULTON. On page 2 of your statement I like the comment:

> When the Department of Defense announced cancellation of the boron fuel production program and the J–93–5 engine, the above-described research was terminated.

You certainly acted quickly, promptly, and without an outside company investigating, didn't you?

Mr. CONLON. We did, sir.

Mr. FULTON. Do you think you were correct in your decision?

Mr. CONLON. We do.

Mr. FULTON. Then, if you look over on page 3, that the chairman has already complimented you on, that is paragraph 5: The amount of boron fuel used by the NASA, in these research programs is small, and therefore the NASA has no requirement for the two boron fuel plants which the Department of Defense is closing.

You will note you state that in the present indicative. They are doing it.

Do you have advice that that is the case because we have heard here otherwise that it is only under consideration, as they do not know their own fuel requirements for their own R. & D. programs, for high energy boron fuel.

Mr. CONLON. I do not know that. My statement is in error there. I was judging on statements in the newspapers.

Mr. FULTON. I am very sorry to hear that. I found a discrepancy with two others here and I thought you might be correct.

Now, going a little further: If you say NASA has no requirement for the two boron fuel plants, you don't actually mean no requirement, period, but you mean no requirement without modification possibly of those plants in order to get the particular boron hydride that you might want to experiment with further. Because you still want to do something on afterburners, ramjets, and turbojets and while you say in this one particular instance—

The problems of using boron fuels in afterburners and ramjets were much easier to solve—

you nevertheless likewise say—

considerable work remains to be done and full-scale engine tests over a wide range of operating conditions would have to be done to obtain a satisfactory turbojet for boron fuel.

That means engine research, doesn't it?

Mr. CONLON. That is right.

Mr. FULTON. For that engine research you would need some reasonable amount of boron fuel, wouldn't you?

Mr. CONLON. If we were to continue, but we have no plan for continuing that research. Only research on boron fuels for rocket motors.

Mr. FULTON. If, on the B–70, they have been able to make such startling advances on engines, flight characteristics, and configuration without going into the afterburner fuel, why couldn't they make further advances of a startling nature by looking into this problem of the boron fuel for the afterburners?

Mr. CONLON. I think they could make further advances in the performance. I assume they didn't have the requirement to do so.

Mr. FULTON. If they are going to use the B–70 at all don't you think it should have the best configuration to give it the best strategic and tactical advantage?

Mr. CONLON. I think I would rather let the Air Force answer that.

Mr. FULTON. Don't you think that as a research man they should go ahead on the research?

You see, some of us are trying to get to the basis of this. We are not prejudging it. You say considerable work remains to be done on full-scale engine tests over a wide range of operating conditions to obtain a satisfactory turbojet engine to operate on boron fuels.

Mr. CONLON. That is right.

Mr. FULTON. Now, I am simply carrying your ideas a little further and saying to you, isn't there a possible field there, and maybe aren't you just quitting a little too soon on this boron high-energy fuel research under NASA, so that you may want to revise your comment to to the chairman here that you have no use for these two plants. You might in a modified state. You possibly might use them if you went ahead on this program under this paragraph B.

Mr. CONLON. Regarding the last question that you have there, I do not visualize that any experiments we would run would utilize 5 to 10 tons of fuel per day. I think we could get ours out of the smaller plants.

Mr. FULTON. Can you visualize any experiments on these engines and on this fuel for these engines that would in any event require a major amount of fuel, or is that just outside your area?

Mr. CONLON. As soon as you went to an engine of 10,000 or 15,000 pounds thrust, then you would need that amount of fuel to run development tests. As you know, it requires many hours of development testing, and as soon as you start development testing, which is done by the engine manufacturer, then you need those quantities of fuel.

Mr. FULTON. Regarding our present hyperbolic fuels for rockets and boosters, we, of course, are greatly concerned about the size, mass, weight, and the various characteristics of them, and we are trying to get something more stable than liquid oxygen and hydrogen.

Mr. CONLON. That is right.

Mr. FULTON. And, as a matter of fact, boron is more stable than those two fuels for handling, isn't it?

Mr. CONLON. It is.

Mr. FULTON. Now, then, we are trying to push the hydrocarbons pretty much, but the question comes up: Why, when you have an intermediate class like boron that we have put a quarter of a billion dollars into, do we now suddenly have everybody turn tail on it and leave it like a dead cat on the doorstep.

Maybe some of us in our questions, when we are getting to the bottom of this, might be trying to find out what we could go ahead with, or what we could salvage. Several questions have been on that. And what direction of research we could go into. And let me ask you, on these tremendous booster engines we now have, the elephant booster engines and rabbit-head payloads, couldn't boron high-energy fuels be used for those on-land operations where they might not be good because of their characteristics for sea operation?

Mr. CONLON. There is a possibility they could be used.

Mr. FULTON. Has NASA now looked into that at all? This committee, you see, has this man-in-space project, and we have the vehicles such as the various types of communications vehicles and we have other types of things that might have another function other than just military usage.

Mr. CONLON. Right.

Mr. FULTON. You could use those under peacetime conditions and they wouldn't have the rigid requirements of, say, a Navy ship or an aircraft that is under wartime conditions and manned. Had you given any thought to that as a field?

Mr. CONLON. Yes. We have a contract with Callery, roughly $200,000 in amount, to produce the fuel for the rocket motor, and they

have a subcontract, I think, with the University of Wisconsin to run certain tests on the fuel characteristics and the fuel will actually be used in rocket motors by Reaction Motors. So that work is underway. That is in addition to the work we are doing at the Lewis Laboratory.

Mr. FULTON. Actually, wasn't it Callery that started a good deal of the research on these boron fuels? Isn't that the case? Haven't they been working on it a long time?

Mr. CONLON. Oh, yes.

Mr. FULTON. And they are adept in many phases of it?

Mr. CONLON. Very much so.

Mr. FULTON. The phases could include medical uses as well as just these space and industrial uses, could they not?

Mr. CONLON. That is possible; yes.

Mr. FULTON. For example, there has been research on the use of boron for destruction of animal tissues and tumors and things of that type.

Has there been any research, opinion, or plan made on that type of research for the use of boron in these other fields? I am trying to see if you have scanned the field to see where boron might be used, because an expenditure of this amount is a tremendous economic tragedy for the country.

Mr. CONLON. No, sir; we have limited our efforts to the problems of space flight and the problems of aeronautical work as given to us by the military. We haven't really devoted time to the possibility of salvaging these plants.

Mr. FULTON. Could you give us the relative value of what you have obtained from your $3,500,000 expenditure on research in this field by NASA, as compared with the quarter of a billion dollars expended by the Air Force and the Navy in attaining their results? What have you gotten for your $3,500,000 compared to what the Navy and the Air Force got for $120 million and $123 million?

Mr. CONLON. Let me put it to you this way: Our work is something like working in a test tube. You find something can be done. Then the next thing you go to a small plant like a pilot plant, or a very small rocket motor for tests or small combustion chambers. We do that, and the work is relatively inexpensive. We get facts. We turn them over to the industry working with it and to the military. Then when they move ahead and design modern weapons, the cost then skyrockets.

Mr. FULTON. Are you inferring that the expense in the Navy and the Air Force was in developing the engines, as distinguished from the fuel, itself, which they could have done in test tubes or just small pilot lines?

Mr. CONLON. No.

Mr. FULTON. What do you mean?

Mr. CONLON. I mean that the cost of engine development, like the J–93–5, is expensive. It requires fuel plant capacity, so the plant, plus the engine development, runs into large sums of money.

Mr. FULTON. Is there any way we can separate that off to find just what the fuel R. & D. is, as compared to the engine components? There must be some way to break this down so we can see what it is. For example, I might show you on the Navy statement here, there is a $3 million discrepancy on it. On page 2, in the next to the last paragraph, it says:

In June 1956 the Navy signed a contract with Callery Chemical Co., for the construction of a 5-ton-a-day plant at Muskogee, Okla., for an estimated cost of $38 million.

You look over on the last of the statement and its says "funding for Project ZIP," and is says "Muskogee high-energy fuel plant construction, $35 million." That is in the same statement.

Now just maybe some of us are interested enough to check this thing through when we find a $3 million discrepancy between three pages of a statement.

That is all.

The CHAIRMAN. Are there any further questions?

Mr. KARTH. Mr. Conlon, you have stated that only recently have boron fuels come into use in the rocket field; is that correct?

Mr. CONLON. That is right.

Mr. KARTH. How recently, sir?

Mr. CONLON. Approximately last year.

Mr. KARTH. The latter part of last year?

Mr. CONLON. Yes, about a year ago.

Mr. KARTH. Isn't one of the 5-ton-per-day plants designed to produce a fuel that can be used for rocket engines and the other one designed to make fuel that will be used in air-breathing engines?

Mr. CONLON. No, I think one plant may be more adaptable to producing fuel for the rocket engine. Let me see if I can make this clear without getting into trouble——

Mr. KARTH. Well, can both of the plants produce fuel that can readily be used in the air-breathing engine?

Mr. CONLON. Yes.

Mr. KARTH. And only one of the plants is more adaptable to providing fuel to be used in non-air-breathing engines or rocket engines; is that correct?

Mr. CONLON. That may be the case. I am qualifying that because we are not sure which of these many boron compounds will be the most suitable for the rocket engine.

Mr. KARTH. And the one that is more adaptable to making fuel that is used in a non-air-breathing engine, is that the last plant that went into construction, or is that the first 5-ton-per-day plant?

Mr. CONLON. I believe they both started at the same time.

Mr. KARTH. When were they first started, do you recall approximately when?

Mr. CONLON. I think we better go back there to the record that was made earlier on that.

Mr. KARTH. In other words, it was approved in 1956.

Mr. CONLON. 1956, as I recall it.

Mr. KARTH. It was a long time, certainly, before boron fuels came into use, insofar as rocket engines are concerned. Isn't that correct?

Mr. CONLON. That is right.

Mr. KARTH. So, really, we are building a plant designed to do something which at the moment we had no use for.

The previous testimony has been that some of this capacity was for rocket engines. Well, if we didn't have any need for this fuel in rocket engines until just recently, then apparently these plants were being constructed or at least one of them was being constructed prior

to the time there was any adaptability for the fuel it was supposed to produce.

Mr. CONLON. Let me clarify that. Both plants will produce a fuel suitable for an air-breathing engine. Right?

Mr. KARTH. This is fine. I am very happy to hear that because I understood when the gentleman from Pennsylvania was pursuing that question with the Secretary, he made a distinction between the two plants, and he said the reason the 450-man plant is probably shut down while the 750-man plant is in operation is because of this.

It occurs to me there is quite a difference between the two plants and the fuel they were adapted to produce. That is the reason for my line of questioning.

Mr. FULTON. You have a good point. They evidently were constructing a plant to produce something for which they had no requirement.

The CHAIRMAN. That comes to my observation. I think the testimony was that they were trying to build a vehicle to suit the fuel.

Mr. KARTH. That may be so.

I was just wondering which comes first, the engine or the horse.

The CHAIRMAN. Are there any further questions?

Mr. HECHLER. Mr. Conlon, I like your prepared statement. It is concise. You summarize the difficulties with this type of fuel very well.

Here on page 2, in the middle of the page, you say:

> At the request of the military services, NASA has supported their boron fuel program with direct consultation services to their project officers.

How often do you really get together and talk to the services about these very points that you have brought out in your research? Are you able to put across the fact that there are serious difficulties? Have you been able to?

Mr. CONLON. Oh, yes. There is very good liaison at the working level. In fact, the military will go direct to the laboratory without any word to headquarters here. We like them to do that and get the latest word on the developments.

Mr. HECHLER. You didn't detect any feeling of "Damn the torpedoes, full speed ahead"? I don't mean to refer to any particular service when I say that.

You didn't notice any feeling like that?

Mr. CONLON. No.

Mr. HECHLER. I believe you have a very impressive and, in a sense, depressing report here, which to my mind should have speeded the closing down of these projects.

Mr. CONLON. Let me go back to that a minute.

There are many problems with any new fuel. If you go back in history, you will remember we talked about 100 octane reciprocating engines. Many people said we couldn't make an engine run that way. The lead in it would be toxic and people couldn't handle it, and all such things. But we made it work.

We are confident that we could make boron fuels work in air-breathing engines if we had to. These were just some of the problems we encountered.

Mr. HECHLER. That is all, Mr. Chairman.

The CHAIRMAN. But other fuels being available, you may never have to do that.

Mr. CONLON. Unless the higher performance which you can get out of an air-breathing engine with a boron fuel is required, we will drop it.

Mr. MILLER. Of course, the reason you went into this—somebody said you were devising a fuel before you had the engine. The reason you did that was because these boron fuels could give you so much more heat.

Mr. CONLON. Forty percent more; that is right.

Mr. MILLER. You had something which would give you 40 percent more heat and what you were doing was just devising an engine, as you go on and tell us here.

Incidentally, in the first part of your statement you say the fuel injection—who developed these injection nozzles?

Mr. CONLON. We do that at the Lewis Laboratory in Cleveland.

Mr. MILLER. In those days, then, this was done by NACA?

Mr. CONLON. That is right.

Mr. MILLER. Was this whole engine developed by NACA?

Mr. CONLON. The J–47 is an old G.E. engine, but all the modifications.

Mr. MILLER. You took a basic engine and you had to put the gadgets on it to make it burn this fuel?

Mr. CONLON. Yes. That is standard practice.

Mr. MILLER. Then, we say that this is somebody's engine after you have done the real work on it. Whose engine was this J–47?

Mr. CONLON. General Electric.

Mr. MILLER. After you put the new nozzles in it and you make it work, and you have to make it work, General Electric still says "This is the General Electric engine"?

Mr. CONLON. We turn information over to the industry, Pratt & Whitney, G.E., Allison, and the rest of them.

Mr. MILLER. I think in turning this information over and letting industry make these claims, merely build up industry and depreciate the work the Government is doing in these fields.

I want to congratulate the Government for the work it has done. It has pioneered the whole thing, as a matter of fact.

Mr. FULTON. Will the gentleman yield on that point?

Mr. MILLER. Yes.

Mr. FULTON. Wasn't there modification in addition on the Pratt & Whitney engine for boron fuel, as well as the General Electric? I believe Olin Mathieson did the work on the fuels, with G.E. on the engine, and I believe it was Callery who did it with Pratt & Whitney—much the same thing. Isn't that the case?

Mr. CONLON. That is correct.

The CHAIRMAN. If there are no further questions, I merely want to make this observation as we adjourn, that regardless of it all, it seems to me that this failure here has given the research and development program a pretty hard knock, and we will have to work out of it in some way to get over it.

Mr. HALL. I would like to ask one question before we adjourn, if I may.

Is it possible that work on the more exotic of the exotic fuels might have been some consideration when the decision was made to abandon this project?

Mr. CONLON. No, I think not.

Mr. HALL. That is all.

The CHAIRMAN. The committee will adjourn until tomorrow morning at 10 o'clock.

(Whereupon, at 4:45 p.m., the committee adjourned, to reconvene at 10 a.m., Thursday, August 27, 1959.)

BORON HIGH ENERGY FUELS

THURSDAY, AUGUST 27, 1959

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met, pursuant to adjournment, at 10:07 a.m., Hon. Overton Brooks (chairman of the committee) presiding.

The CHAIRMAN. The first witness we have comes from the Callery Chemical Co. He is Dr. William H. Schechter, vice president of the operations of that corporation.

Dr. Schechter, the committee is happy to have you here this morning. As you know, the committee feels that this is a very important matter. If you have a prepared statement we will be glad to have you proceed with it.

STATEMENT OF DR. W. H. SCHECHTER, VICE PRESIDENT, CALLERY CHEMICAL CO.; ACCOMPANIED BY J. S. BARDIN, MANAGER OF PRODUCTION; ARCH MILLER, CONTROLLER; AND LLOYD N. CUTLER, WASHINGTON COUNSEL

Dr. SCHECHTER. We have a statement here which answers a number of the questions asked by the committee staff and would like to submit it in its entirety for the record but will only read a portion of it.

My name is W. H. Schechter. I am vice president, operations, of Callery Chemical Co. I hold a doctor's degree in chemistry from the University of Kansas. Before receiving my doctor's degree, I spent 4 years at the Naval Research Laboratory in Washington, D.C., as a research chemist. I joined Callery in 1949 and have been associated with the research, development, and production aspects of Callery's boron fuel program since that time. I was originally responsible for the chemical research and engineering aspects of the program, and for the past 3 years have also been in charge of the production and marketing sides of the work. I am the author of a number of scientific papers and hold several patents in the boron field and related fields.

I am accompanied by Mr. J. S. Bardin, manager of production for Callery, who supervised the engineering and construction of the Muskogee, Okla., plant. Mr Arch Miller, controller of our company, and our Washington counsel, Mr. Lloyd N. Cutler, of the firm of Cox, Langford, Stoddard & Cutler.

Callery is pleased to respond to the committee's invitation to testify as to its experience in the boron fuel field. The information contained in this statement is unclassified to the best of our knowledge. Callery will also be pleased to submit any classified information which the committee may request and which we may be authorized to furnish.

I want to emphasize at the outset that we do not regard the story of the boron fuel program as the story of a failure or mistake, either by the armed services or by the companies and the scientists and engineers who have done the work. We regard it as the story of a major technical and industrial achievement.

In any program of scientific research, particularly in the military field, it is often necessary to explore simultaneously various methods of accomplishing a particular end objective. At the beginning no one knows which method will prove to be the best. Progress made in pursuing one method often stimulates progress in competing methods. And it often happens that several of the methods pursued to achieve one objective produce basic knowledge that becomes of even greater value in pursuing another objective.

So it has been in the case of the boron fuel program. We have known for some time that boron fuels deliver over 40 percent more energy per pound than conventional jet fuels. With boron fuel it is therefore possible to extend range or increase payload by a very significant margin, often big enough to make the difference between accomplishing a mission and failing to accomplish it at all. And as the NASA testimony yesterday established, we now know that the technical problems involved in using boron fuel in turbojet or ramjet engines can be solved.

That knowledge is fundamental scientific and military knowledge, and its importance far transcends the immediate utilization of boron fuel in any particular single item of military hardware. As the committee knows, the knowledge of boron fuel's value came along at a time when the Air Force had a requirement for such a fuel to accomplish the mission of the B–70 bomber. As a result, two multimillion-dollar production plants were built on a time schedule phased to the development of the B–70 bomber. Meanwhile, as the committee heard yesterday, great progress was made on another method in achieving the B–70's mission—the method of improved airplane design—and as a result boron fuel no longer appears to be required for the B–70.

But this progress made in B–70 aircraft design in no way establishes that the boron fuel program is a failure or mistake. It remains true that boron fuel still delivers 40 percent more energy than conventional fuels and that boron fuel appears to be practical for jet engines. We believe that other military requirements for boron fuels are bound to come along in the near future. You heard testimony yesterday that boron fuels promise to play a key role in powering guided missiles. As the committee knows, there have been press reports that the Russian Sputnik III, and Lunik, which went into orbit around the sun, were powered by boron fuel. Other military requirements are likely to develop for aircraft or missiles utilizing turbojet or ramjet engines which can best be powered by boron fuels. The impetus of the Navy and Air Force boron fuel program has launched a large variety of university research projects in many new areas of the boron field, which are soon likely to result in other major practical developments.

The construction of the two production plants has answered one of the biggest technical questions of all, by proving that boron fuel can safely be manufactured in quantity at an acceptable price. We are

confident that the next 5 to 10 years will prove the value of the money spent and the scientific and engineering effort which we and many others have invested in boron fuel development.

1. CALLERY'S ROLE IN THE BORON FUEL PROGRAM

During World War II, the Naval Research Laboratory began to study boron hydrides, then little known laboratory curiosities, with the idea that their properties could potentially be of military importance by enabling aircraft or missiles to fly farther, higher, or faster, or to carry heavier payloads.

The simplest boron hydride is diborane, and this is the major building block for the other boron hydride compounds. In 1946, a Navy contract to make the first production quantities of diborane in the United States—200 pounds at first, later increased by an additional 1,500 pounds—was granted to our parent company, Mine Safety Appliances Co. Three Mine Safety scientists had begun studies in this field in June of that year, using company research funds.

In April 1948, because of growing Government interest in the defense potentialities of boron chemicals, Callery Chemical Co. was incorporated as a subsidiary of Mine Safety Appliances Co. In September 1948 this new company received the first of several increasingly significant research and development contracts from the Bureau of Aeronautics. We developed a process to produce the first pentaborane, and made production quantities of this high energy liquid for the Navy.

In May 1952 the Bureau of Aeronautics launched Project ZIP, a multi-million-dollar project to discover liquid high energy fuels and to develop practical processes for their production. Callery was selected as one of the two prime contractors. We added to our already competent and experienced research, development, and production team, and at the Navy's request, we shared our background of experience and knowledge of boron hydride chemistry with the Mathieson Chemical Corp., the other prime contractor, who was brought into the program without prior experience in this field.

Meanwhile, to accelerate the investigation of many facets of uncharted technology, Callery subcontracted and coordinated research programs at 23 universities and 13 companies and research institutes. This program provided Callery almost overnight with the talent, experience, and imagination of about 200 scientists and technicians, most of whom could not have been made available for this program in any other way. This program was under the guidance, direction and supervision of Callery scientists. This subcontracting program was reduced in size as Callery's own technical staff was expanded.

By 1956 Callery's research team exceeded 150 technically trained people as well as over 300 technicians and craftsmen. These people devoted themselves entirely to work on the chemical aspects of Project ZIP. The Navy assigned to other contractors the responsibility for developing engines to burn these fuels.

In August 1954 the combined efforts to the Callery team led to shipment of the first process-development quantity of HiCal high energy fuel. In April 1956, the first pilot plant production of HiCal was achieved at the Callery research laboratories in Callery, Pa. Callery

received one of the 1956 Chemical Engineering Achievement Awards for its part in the boron program. These achievements resulted in a Bureau of Aeronautics contract in June 1956 for Callery to design, engineer, and construct a plant at Muskogee, Okla.

During the engineering phase of the work on the Muskogee plant, the Navy expressed interest in acquiring small quantities of boron fuel for engineering development and other experimental purposes. Callery therefore designed and built at its own expense a 250-pound-per-day plant at Lawrence, Kans. The cost of this plant was financed in part by a small Navy production order for boron fuel.

Apart from the fuel produced in Lawrence, the design and operating experience acquired at the Lawrence plant was of enormous assistance in solving design and production problems at the larger Muskogee plant. The identical processes successfully operated at the Lawrence plant were incorporated in the Muskogee plant design.

To further the progress of its expanding boron fuels program, Callery solicited the assistance of Gulf Oil Corp., which acquired a one-half interest in Callery and furnished important financial and technical assistance.

Since boron hydrides were know to be toxic, the medical safety aspects of Project ZIP were emphasized from the beginning of the program. Medical knowledge of the physiological effects of boron chemicals was extremely limited at the beginning of this program. Accordingly, investigations of such aspects as mechanisms of body attack, toxicity levels, symptoms of exposure, and clinical studies were coordinated among various groups: Callery, University of Pittsburgh (a Callery subcontractor), Olin Mathieson, University of Maryland (an Olin Mathieson subcontractor), and Army Chemical Center. Each group was assigned specific problems to study, and the results of each investigation were made available to all groups.

Callery's safety record, initially comparable to that of similar chemical plants, has progressively improved every year and thus attests to Callery's success in this area.

Construction of the Lawrence plant was started in the spring of 1957. The plant was finished in the summer of 1958, and produced approximately 20 tons of boron fuel. The Navy had no research need to purchase additional quantities from the Lawrence plant, and the plant has since been used primarily as a production engineering center to solve problems arising at the Muskogee plant.

Ground was broken for the Muskogee plant in March 1957. The plant was completed and the last unit was ready to go on stream during the week of August 10, 1959, when the Navy sent out its August 12 telegram terminating the production contract.

By this time, Callery had recruited and trained 463 employees to work at the Muskogee plant. Many of the key personnel at Muskogee were transferred from the Callery laboratories near Pittsburgh and these people trained the inexperienced workers hired at the plant site.

Callery's present program consists of: (1) placing Muskogee on a standby basis, (2) operating the Lawrence plant at a reduced level to carry out production engineering studies and limited production designed to demonstrate what fuels and basic boranes can be made economically in the Muskogee plant, and (3) continuing the research

and development program at a reduced level. With no assurances of future support, these temporary measures are not sufficient to maintain a production capability for more than a very brief period.

Callery's sole business is the production of boron fuels, and Callery's only customer is the armed services. Callery has made extensive efforts to develop commercial applications for products which can be produced at the Muskogee and Lawrence plants, but no significant additional markets have been developed to date.

If the termination is effective in its original form it will be a knockout blow to Callery Chemical Co., the pioneer company whose efforts are devoted almost entirely to the boron fuel program.

2. HISTORY OF THE MUSKOGEE PLANT

At the committee's request we are submitting a history of the Muskogee plant.

The plant was constructed for $3 million less than the original estimated cost and employs approximately 460 people.

The CHAIRMAN. What was the cost of the plant as finally indicated?

Dr. SCHECHTER. The final figures are not in but it will be in the neighborhood of $35 million.

Mr. FULTON. That explains the discrepancy in my question yesterday between the two cost figures.

Dr. SCHECHTER. Yes, sir.

The CHAIRMAN. The estimated cost was $38 million and the actual cost was $35 million.

Dr. SCHECHTER. Our contract called for $38.4 million.

Mr. FULTON. You were able to save then by your construction under your management, about $3,400,000; is that right?

Dr. SCHECHTER. That is roughly right.

Mr. HECHLER. On page 10 there is a figure of $31 million. I wondered how that related to what you just said.

Dr. SCHECHTER. That is the production contract that is referred to there.

I would now like to summarize the history of the Muskogee plant. In June 1955, Callery was awarded a contract in an amount of $293,616.75 to undertake a preliminary engineering study of the work required to build a high-energy fuel plant, and to estimate the cost of such a plant. Based on this study and on technical information supplied from the research and development efforts conducted at Callery, Pa., a proposal was made to the Navy Department to construct a large-scale plant at Muskogee, Okla.

In June 1956 Callery was awarded a contract by the Navy Department for the design, construction, and equipment of a plant capable of producing approximately 5 tons per calendar day of high-energy fuel at a total estimated cost of $38,454,615. The contract completion date, as amended, is December 31, 1959. This is a cost-reimbursement contract with no fee and no return on capital investment.

Callery accepted the contract on this basis only because it expected to operate the plant on a production basis in the future. The termination effectively stops any further work which could compensate Callery for this extensive investment of management and technical effort.

Ground was broken at the Muskogee site on March 8, 1957, and construction was completed in August of 1959, with an expenditure of only 90 percent of the funds originally appropriated, resulting in a saving to the Government of approximately $4 million. Callery undertook a major and unique construction program of a type unprecedented in Navy experience, and performed it in an efficient manner and well within the funds allocated.

In July 1957, Callery submitted a proposal to start up and operate the Muskogee facility and to produce high-energy fuel. A cost-plus-fixed-fee contract was entered into as of April 25, 1958, for an estimated cost of $31,367,663. Materials and services essential to start up, operate, and produce high-energy fuel were to be provided by Callery with completion to be accomplished by June 30, 1960.

Callery proceeded with startup operations and the Muskogee plant was ready to go on stream as a completely integrated unit during the week of August 10, 1959. The termination notice was received on August 12, 1959. This termination notice was modified by the Navy Department on August 13, 1959, ordering Callery to place the Muskogee facility in a standby status and to continue production engineering work currently in progress. Steps were taken immediately upon receiving the Navy's notice to reduce the work force and physically prepare the plant for standby.

In preparation for startup, Callery had entered into various utility contracts and raw material supply contracts requisite to operation. Detailed plans for operation had been completed, including selection of personnel, operating policies, supervisory and operational training program, accounting methods and procedures, job descriptions, and startup procedures and sequences. A general production schedule for startup to full capacity had been prepared. Raw material had been reviewed and production supplies established. In addition, between 7 and 8 million pounds of intermediate materials had been produced at the Muskogee plant in preparation for integrated production.

The operating organization at the Muskogee site had reached a level of 463 employees and it was expected that peak employment would not exceed 500 at full production. It had been demonstrated at the Lawrence, Kans., plant that the process used at Muskogee would produce HiCal high-energy fuel, meeting original Navy specifications at near design capacities and cost, and in fact the first three of the four process units have been successfully operated at Muskogee.

Operating funds under contract NOa(s)–58–395–c, $31,367,663, were appropriated in installments and currently only $13,125,000 have been made available. At this date approximately $5 million of the appropriated funds remain uncommitted.

3. CALLERY'S FINANCIAL INVESTMENT IN THE BORON FUEL PROGRAM

Callery's financial contribution to this effort over the years through both invested and borrowed capital has been quite substantial, reaching $15,510,000 early this year. These funds have been provided with little or no profit contribution. Over the 11-year period ending December 31, 1958, average annual net profit amounted to $12,065 which is 0.0461 percent of the average annual assets of $2,613,258 employed in the business. No dividends have been declared or paid to Callery's stockholders from the date of incorporation to the present time. All

earnings have been ploughed back into the business. Moreover, the $38 million Government plant at Muskogee was constructed on a cost basis without fee to Callery.

4. NAVY'S INVESTMENT IN THE CALLERY PROGRAM

Navy funds used in the Callery program were provided under a series of research and development contracts, with supporting facilities contracts to build pilot plant units. Production contracts were issued covering the purchase of fuel at the Lawrence and Muskogee plants. A table summarizing the Navy funds, allocated and expended, follows.

I will not take time to read these figures. They are available for your review.

(The table referred to follows:)

	Total of all funds allocated	Projected total of all funds expended through July 31, 1959 [1]
Facilities contracts:		
Callery, Pa., plant (R. & D. facilities)	$5,574,120	$4,459,779
Muskogee plant (production facilities)	38,454,615	34,944,298
R. & D. production contracts:		
Callery plant	30,190,370	28,864,743
Lawrence plant	3,939,716	3,939,716
Muskogee plant	31,367,663	8,565,717
Grand total	109,526,484	80,774,253

[1] Does not reflect termination costs.

It should be noted that expenditures above represent totals to July 31, 1959, and do not include claims and costs incident to the termination of the program, which are not known at this time, but which will no doubt run into millions of dollars.

The next section deals with the quantity of fuel produced and we will skip over to page 15.

(The section referred to follows:)

5. QUANTITY OF FUEL PRODUCED

"HiCal" is Callery's tradename for boron-based high energy fuels. The series numbers denote different grades of fuel for various purposes.

During the period from 1957 to date, Callery has produced over 16 tons of HiCal–3 for the Navy and 2½ tons of a special fuel, HiCal–3D, for the Air Force. Of the HiCal–3 produced for the Navy, about 15 tons were produced at the company's plant at Lawrence, Kans.

In addition, 380 pounds of decaborane and 46 pounds of HiCal–4, a new higher energy boron fuel, have been produced. These and smaller amounts of HiCal–5, a fuel for use at very high temperatures, were produced for study purposes.

In the final month of full plant operation at Lawrence, Kans., the production exceeded that set forth in Callery's original bid proposal and the cost per pound originally quoted was met.

Decaborane, an important chemical for probable use in rocket propellants and advanced fuels, is being produced in experimental quantities at Lawrence. As I will discuss in a moment, recent work has indicated that both the Lawrence and Muskogee plants can be converted at moderate cost to the production of decaborane.

During start-up at Muskogee, a number of important intermediate chemicals were produced and stockpiled for subsequent production use. Such intermediate chemicals and raw materials on hand at termination total approximately 12,500,000 pounds (6,250 tons).

6. CALLERY'S SUGGESTION FOR THE USE OF THE MUSKOGEE PLANT

The Muskogee plant was designed specifically for the production of diborane and HiCal–3, and cannot be used for the production of other chemicals without alteration or additional facilities. We know of no industrial use for this plant.

The plant can be operated economically to produce boron fuels at design capacity, or as low as 10 percent of design capacity, to meet present development fuel needs. All boron fuels or propellants currently being evaluated are produced from diborane, which represents 80 to 90 percent of the final fuel cost. We believe that the Muskogee plant provides the cheapest source of diborane in existence today, and probably for the next 3 to 5 years.

Therefore, we believe this plant should be used for interim production of boron fuels—at partial capacity—and for further research and development of boron fuels or propellants. Other boron fuel materials such as pentaborane, decaborane, HiCal–4, HiCal–5 or derivatives of these materials can be produced with minor additional facilities.

We believe that the cost of adding these minor additional facilities is very low when compared to the basic cost advantage of the Muskogee plant as the cheapest existing source of diborane, the fundamental building block of all boron fuels. Because of this cost advantage the small investment required to install additional facilities would be recovered by the Government in a very short time, even if the plant is operated only to produce the quantities of fuel needed for current research purposes. We believe that the Muskogee plant can produce these quantities more cheaply than any other existing source.

We understand that the Arthur D. Little Co. is now studying the comparative advantages of Muskogee and the other existing facilities as possible sources for current research requirements for boron fuel production. We assume that the selection of the plant to supply these requirements will be made on the basis of these factors.

The Muskogee plant can also be utilized as a research and development facility for military-sponsored programs. In addition to supporting service and office buildings, the plant includes an ultramodern laboratory and maintenance shops. The plant is particularly well suited to the development of new boron propellants because of the low cost of diborane available; however, the military usefulness of the facilities and technical personnel available is not limited to boron propellants.

It is possible that the nonprocess portion of the Muskogee plant, consisting of administrative buildings, shops, steamplant, water system, etc., could be utilized in the production of other military or industrial chemicals. These nonprocess facilities represent about one-third of the plant cost. This site was specifically selected after an extensive site survey covering more than 50 locations. The site is ideally adapted to military chemical production based on the following factors: (1) low-cost utilities, (2) excellent fresh water supply and water for waste disposal, (3) good labor supply (class C area), and productivity, (4) excellent cooperation of State and local authorities, (5) ample land for expansion (the present plant occupies 385 acres of the 1,275-acre Government-owned site).

7. SUMMARY

The Callery Chemical Co. has devoted 13 years to the boron fuel field and has made major technological contributions during that time, as the record shows. During this time a team of highly trained technical manpower has been assembled and integrated into a productive organization. Many of these people have devoted 5 to 10 years of their lives to this technically complex and demanding field of chemistry, and have become homeowning citizens in the communities in which the plants are located. In Muskogee, for example, they make up over 20 percent of the total industrial payroll. The sudden termination of the Muskogee contract has destroyed this community buildup, the savings and homes of the individuals, and the morale of Callery's entire technical staff.

Diborane is the key boron hydride used to prepare boron fuels. It accounts for 80 to 90 percent of the cost of the finished fuel. Thus it is the key to low cost fuel production; and from it a wide variety of military fuels and propellants can be made as the rapidly changing fuel technology develops in the next few years.

Callery has developed an economical process to produce boron fuels and has proven it out in pilot plants and in the company-owned smaller scale production unit at Lawrence, Kans. This plant is an almost exact duplicate in miniature of the Navy's Muskogee plant. Callery feels that its process gives the most economical diborane available today and for the next few years. An even more advanced process is in the latter stages of development in the laboratory and is expected to maintain Callery's position in the future with respect to supplying the most economical diborane.

In light of the Government's decision not to use boron fuels in presently conceived aircraft, the potential of these fuels will be realized in powering the missiles and rockets of the future.

Unfortunately, the planned aircraft demand for boron fuels precluded the possibility of these materials being tested for missile and rocket use until recently. Therefore, development of missile engines capable of using boron fuels is in its early stages. These newer developments show tremendous potential particularly in ramjet and rocket applications. Several new propellant and propulsion system concepts have been developed in recent months based on boron fuels. Dramatic increases in performance are foreseen. These are the areas

where the expensive know-how developed in the boron field will pay off handsomely in the next few years.

In our opinion, this promise dictates a holding action on the part of the Government. The existing production plants represent sufficient installed diborane capacity to supply the missile program for a number of years. We believe the productive capacity of the Lawrence and Muskogee plants must be maintained and the highly trained technical staffs kept together to enable the Government to realize a generous return on the many, many millions already invested.

Callery is very much interested in continuing to help the Government realize the potential of these exotic and powerful fuels. In fact, this is the only business interest we have.

This concludes our prepared statement. We will be pleased to answer any questions the committee may have.

The CHAIRMAN. I want to thank you very much on behalf of the committee. Yours is an excellent statement of your situation at this time.

Mr. FULTON. May I join the chairman in that comment. I think it has been well prepared and presented.

The CHAIRMAN. It gives your viewpoint on this basic problem.

May I ask you this: When did you have the first knowledge that this contract for the operation of this plant and your facilities would be made?

Dr. SCHECHTER. We heard some rumblings last fall that the Navy's program had been shifted. We had no definite information as to the possibility of contract termination until just a week or so before we received notice.

The CHAIRMAN. That was the first real notice that you had that there would be a termination. Up to that time would you say your program was "full speed ahead"?

Dr. SCHECHTER. Right.

The CHAIRMAN. Have you any misgivings in reference to the decision to terminate this operation?

Dr. SCHECHTER. Well, naturally we have put a lot of effort into this over a number of years and feel quite strongly about having it left in this condition. We feel there is a lot of potential in these materials and that time will prove this.

The CHAIRMAN. But you feel now, according to your statement, that these potentials would be in the field of rockets and missiles rather than manned aircraft?

Dr. SCHECHTER. The military has made a decision with which we cannot particularly argue.

We do feel, though, that they have potential in these newer fields, fields which have not been explored properly yet.

The CHAIRMAN. Why do you say you cannot argue with the military on that?

Dr. SCHECHTER. That is a military decision. We are concerned with making chemicals and we feel we know how to make the chemicals and we know a little something about how these materials might be used.

The CHAIRMAN. If you feel the military is wrong, though, you would not hesitate to say so? You are backed up by a corps of 200 chemists in your organization, offering an experience of many years.

Dr. SCHECHTER. We only look at one aspect; that is, the chemical aspect.

As to logistics and military needs, we are not competent to comment in that area.

The CHAIRMAN. All right, then, we will accept that. If there is a future for boron fuel, the future is in the missile and the rocket development. That is correct, is it not?

Dr. SCHECHTER. That is right.

Of course, the military needs may change to where turbojet applications may come back in. This is entirely conceivable.

The CHAIRMAN. But at this time you do not see that.

Dr. SCHECHTER. No, sir.

The CHAIRMAN. Since that is the case, you stated that the production you envision would be only for a very brief period. Would it be the production of the Lawrence plant or the Oklahoma plant?

Dr. SCHECHTER. As indicated by Admiral Dixon yesterday, these plants have an assured life only up until about October 1. What use might be made of them beyond that is unclear at this time.

The CHAIRMAN. What about the Callery plant, itself?

Dr. SCHECHTER. The Callery research and development facilities are partially engaged in some of the newer programs and partially in research related to some of the programs tied in with Lawrence and Muskogee.

We have a fair backlog of research and development there and will continue on a reduced basis.

The CHAIRMAN. You can use the Callery research and development plant for other purposes, can't you?

Dr. SCHECHTER. Yes.

The CHAIRMAN. But the large plant is not adaptable at this time to other purposes.

Dr. SCHECHTER. The production plants in general are not very adaptable to other purposes.

The CHAIRMAN. Then both of the production plants—do you have a production plant, too, at the Callery plant?

Dr. SCHECHTER. No, sir.

The CHAIRMAN. The Lawrence plant which is yours, and the Muskogee plant, which belongs to the Government, are suitable only for making diborane; is that correct?

Dr. SCHECHTER. Diborane is available there in large quantities at low cost. Also this plant can be converted and we would recommend that it be converted to a facility for other research and development. It has good laboratories, and a technical department with about 60 people in it who can be used for research and development in the boron fuel field or in other R. & D. activities.

The CHAIRMAN. Now that is what the committee would like to know. Can it be used for other than making boron solid propellants? You say, in the initial stage, 90 percent of it supports production of diborane.

Dr. SCHECHTER. Right.

The CHAIRMAN. What else can that plant be used for without too much expense?

Dr. SCHECHTER. From a production standpoint it can readily be modified to make boron derivatives which are based on diborane.

You see, with diborane representing 80 percent to 90 percent of the capital investment in that plant, any modifications to give other boron propellants or chemicals will be minor.

The CHAIRMAN. What would you use the diborane derivatives for?

Dr. SCHECHTER. Propellants, fuels, and research in areas related to this.

The CHAIRMAN. Not the type of propellants that have been rejected by the services, though.

Dr. SCHECHTER. No; the more advanced propellants.

The CHAIRMAN. So it really pushes the matter off into missiles and rockets and mostly would you say to NASA?

Dr. SCHECHTER. There is a continuing requirement for various of these fuels. I think, as the services have indicated—they did not specifically state what their requirement would be because I think they are just studying this—there is going to be a need, we feel, for appreciable quantities.

The CHAIRMAN. That is your only hope at this time for the use of the plants?

Dr. SCHECHTER. No; there is one other thing that can be done. We have this staff of 60 technical people who are now a part of the standby crew.

They could just as well be engaged in other research and development and serve two purposes, there.

That is, maintain the potential of their plant and at the same time, do constructive research and development that is needed in other parts of the military program.

There is a lot of chemical research and deveopment going on in the military and a good many of these technical people in that plant have had previous experience in research and development.

The CHAIRMAN. When you say "maintain the potential of the plant," you mean maintain its operation?

Dr. SCHECHTER. No; on a standby basis, where we would have the opportunity to come back to full-scale operation were it needed.

The CHAIRMAN. You would have these people down there doing R. & D. work and at the same time maintaining the plant in a standby condition?

Dr. SCHECHTER. Yes, sir.

The CHAIRMAN. Could that be done satisfactorily in your judgment?

Dr. SCHECHTER. Yes, it could.

The CHAIRMAN. What would you do in reference to these contracts that you have with the colleges and universities that you refer to?

Dr. SCHECHTER. Most of those have been terminated at this time. We started out with a large number but those gradually decreased.

The idea there was to get a lot of fundamental research going, which can be done by the universities. As it got more toward the applied side it had to be done in our own laboratories or in the research institutes because universities are not set up in general to do applied research. They do not like to do it.

The CHAIRMAN. Is your plant down there at Muskogee more adaptable to change for other uses than the plants of the Olin Mathieson Corp.? You do not have to answer that categorically. I do not want you to get in trouble with Olin Mathiseon—we will hear from them—but will you elaborate on that?

Dr. SCHECHTER. We feel quite strongly that we have the most economical source of diborane and for that reason we feel this plant has a lot of potential in the future of the boron propellant programs.

The CHAIRMAN. Your plant in Muskogee cannot be used for anything other than making diborane?

Dr. SCHECHTER. No, that is not right. We can convert diborane to other intermediates in our equipment in the fuel portion of the plant. We are doing some work in our Lawrence plant now to make decaborane and other intermediates and there perhaps will have to be some additional capital investment made in the plant, but it would be minor compared to the total cost of the plant, and we think that the low-cost diborane will compensate for the additional capital investment needed.

The CHAIRMAN. What do you figure your entire investment in this project to be as of this year?

Dr. SCHECHTER. As a company, overall?

The CHAIRMAN. Yes.

Dr. SCHECHTER. Do you mean Callery's investment, or the military investment?

The CHAIRMAN. Callery's investment. We know what the military investment is.

Dr. SCHECHTER. I refer you to Mr. Miller, our controller, to answer that question.

Mr. ARCH MILLER. The company has invested $15.5 million.

The CHAIRMAN. Mr. Miller?

Mr. MILLER. No questions.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. In referring to the $15,510,000 in invested and borrowed capital, as of a time early this year, can you divide off for us what was actually capital contribution and borrowing?

Mr. ARCH MILLER. The capital contribution was approximately $5 million.

Mr. FULTON. So your company has put in $5 million of its own money in addition to what it has borrowed?

The borrowing then would be $10,510,000; right?

Then on the return on your assets you have $2,613,258 as the annual assets employed in the business. Can you advise us again of your return, then on that to your stockholders and to your company profit-and-loss statement?

Mr. ARCH MILLER. For the period 1948, when the company started, through December 31, 1958, the total accumulation of surplus has been $132,000, or an average of $12,000 per year for that 11-year period.

Mr. FULTON. What amount of that had been paid in dividends from your surplus account?

Mr. ARCH MILLER. None.

Mr. FULTON. So your stockholders have received nothing on their investment in the Callery Co.?

Mr. ARCH MILLER. That is right.

Mr. FULTON. What would you say that was as an annual return on the assets invested and employed in this particular type of business production of boron fuels?

Mr. ARCH MILLER. The average annual assets of Callery Chemical Co. during this same 11-year period has been $2.6 million. The surplus resulting from operations is equivalent to 0.0461 percent.

Mr. FULTON. You people were given a contract to build the plant at Muskogee. Would you please explain what the terms of that contract were as to the cost or the amount that you would be paid; and also as to what you actually saved in the construction of the plant over the Government estimates.

Dr. SCHECHTER. We were given a contract of $38.4 million on a cost basis, with no fee, and we will have completed this plant for about 10 percent less than we originally estimated and have made no profit on that sum.

The CHAIRMAN. You made no charge at all, did you?

Dr. SCHECHTER. That is right; it is a no-fee contract.

Mr. FULTON. Then how much would you say in dollars you had saved the Government by this economical construction?

Dr. SCHECHTER. Well, certainly three or four million dollars.

Mr. FULTON. And what is customary for an architect's fee, for example, on supervising the construction of such a plant?

Dr. SCHECHTER. I am afraid we do not have too good a figure. Perhaps 5 to 10 percent would be reasonable.

Mr. FULTON. That would be somewhere between a million and a half and three and a half million dollars, depending on the modifications there might have been as the plant went along, if we were charged an architect's fee.

Dr. SCHECHTER. You realize of course we did this——

Mr. FULTON. Could you answer my question?

Dr. SCHECHTER. Would you state the question again, please?

Mr. FULTON. Mr. Reporter, will you read it, please?

(The reporter read the question.)

Dr. SCHECHTER. Yes.

Mr. FULTON. Will you give your explanation now, please?

Dr. SCHECHTER. You realize, when we took this contract at no fee, we anticipated we would have a long operating contract on which to make some profit later and partially compensate us for this work.

Mr. FULTON. So that when the cancellation came, the cost that you have laid out on your statement on page 13 did not include claims and costs incident to the termination of the program because they can not be estimated at this time—that they will run into large sums if a cancellation is completed and the termination made as now scheduled; is that correct?

Dr. SCHECHTER. Yes, sir.

Mr. FULTON. The problem should then be taken into consideration as to whether this plant should be discontinued in operation or continued in some degree of operation; should it not?

Mr. SCHECHTER. We feel so.

Mr. FULTON. And likewise, it should be taken into consideration when we are deciding which is the most economical plant for the production of the diborane and the various derivatives; is that not correct?

Dr. SCHECHTER. That is correct.

Mr. FULTON. Then diborane actually is one of the fundamental bases of all boron fuels, is it not; so that you can make various molec-

ular combinations that will result in various other characteristics and the modifications of plant structure would be relatively minor to get such adjustments; is that not right?

Dr. SCHECHTER. Yes, sir.

Mr. FULTON. Then the question comes up, too, of what would you say would be the most economical plant capacity percentage for operating the Muskogee, Okla., plant?

Dr. SCHECHTER. The most economical is always the most you can make in the plant. At full design or slightly over.

Mr. FULTON. What is the least economically possible percentage that it could be operated at?

Dr. SCHECHTER. We do not have complete figures on that but certainly we feel it can be operated economically at the 10-percent level.

Mr. FULTON. Then the question comes up of whether you have had adequate notice.

When your plant at Muskogee was going into operation the week of August 10, you then received a telegram from the Navy on August 12, so that it was actually just summary notice; was it not?

Dr. SCHECHTER. It was short notice.

We had started up a good bit of the plant. It was only the last process unit which had not been started up at this time.

Mr. FULTON. So the notice, whether it was formal or informal in character, was that you should terminate operations at the Muskogee plant; right?

Dr. SCHECHTER. Right. Although we had realized that the Air Force and Navy had been discussing this for several months.

Mr. FULTON. You were able though to shut down and discontinue operations economically when that was given; were you not?

Dr. SCHECHTER. Yes, sir.

Mr. FULTON. Do you see any reason why the same procedure should not be used for any other plant of any other company that is operating at a production of the same capacity—that is, 5 tons daily capacity. That brings up, of course, the question which I do not want you to refer to: Why is one plant continued while determining whether it is economical to shut it down and in the other case the same type and amount of capacity plant is promptly shut down in a week to 10 days.

What is the difference in keeping one going and in summarily terminating the other one?

Dr. SCHECHTER. As you suggest, I should not answer all of that.

Mr. FULTON. What I want to know, is there any difference in plant equipment that would make a difference?

Dr. SCHECHTER. I should clarify one point, that our plant is not entirely on a standby basis at this time. We are rapidly getting toward a standby. We were given orders to go on a standby basis and have released approximately 200 out of 460 employees, and will release the others as rapidly as we can get the plant physically into shape for leaving it in standby.

Mr. FULTON. My point has been previously that I want these scientific teams maintained because I feel that that is one advantage Russia has had over us with their system, because it seems they have moved their teams from one scientific project to another rather than just dismissing them.

The employment, unemployment, and reemployment of scientists and pirating of scientists among companies is one of the drawbacks to our program.

You people would like to keep your scientific team together, would you not, and use it on other phases of research and development, both in the astronautics field as well as aeronautics and the chemical field, as well as in the military field; would you not?

Dr. SCHECHTER. We certainly would.

Mr. FULTON. Do you feel that it is an adequate team and that it is on a level with other scientific teams in the country in the same area of reference?

Dr. SCHECHTER. Yes, sir; I do. I think the record proves that.

Mr. FULTON. As I understand it from your statement, you people seem to have taken the burden of the research and development in this field of boron fuels and diborane and derivatives; is that not right?

Dr. SCHECHTER. Yes, sir.

Mr. FULTON. And if the contract is canceled, it pretty much means the end of your company as well as the communities dependent on it; doesn't it?

Dr. SCHECHTER. It would certainly be disastrous to us.

Mr. FULTON. It would mean quite a breaking-off point. You would have to reorganize the company and reassemble teams for other purposes during this carryover period?

Dr. SCHECHTER. That is right.

Mr. FULTON. This is your whole company's purpose—the Callery Co.—while in the Olin Mathieson Corp. it is only one of their many purposes; isn't it?

Dr. SCHECHTER. That is what I understand.

Mr. FULTON. From my own knowledge I know that Olin Mathieson Corp. is trying to cut down on the number of programs it is in because they feel they are too diversified. Therefore, in that particular company, it would not be a major part of their business; would it? You can answer that. It is not a major part of the Olin Mathieson Corp.'s business?

Dr. SCHECHTER. It is not a major part, as far as I know. I think they should answer that, and not us, though.

Mr. FULTON. Between a company trying to cut down its line, such as the Olin Mathieson Corp., and one whose very existence depends on the research and development that they have been primarily and the most forward looking in, you can see what my feeling is on maintaining scientific teams.

I might say further that I am interested in seeing that this research and development is spread pretty well around this country, rather than concentrated in one particular area, so that I think that should be another factor taken into consideration.

The CHAIRMAN. One of these plants is in Pennsylvania, isn't it?

Mr. FULTON. I might say to you, I don't know where Callery, Pa. is. Where is it?

Dr. SCHECHTER. It is about 25 miles north of Pittsburgh.

Mr. FULTON. Coming from the south of Pittsburgh, I am one of the southern Congressmen.

The CHAIRMAN. May I say this, seriously, if my colleague will suffer an interruption: I think that the experience that these two companies

have gained in this project are certainly worthy of preservation, if it is possible to do so.

Mr. FULTON. Well, it looks to me like one company made the early development of this boron fuel, pioneered in it, ran the scientific research, and the other company then was brought in pretty much as an industrial expansion of the program. So that the question comes up, when we come to deciding who shall continue, I think that each company should be treated alike and that the Government should not only get the most economical source, but look at the distribution throughout the country of these scientific facilities, and also see the impact on the community of a good Congressman called Mr. Ed Edmondson, of Oklahoma.

Do you agree with that, Congressman Edmondson?

Mr. EDMONDSON. Wholeheartedly.

Mr. FULTON. Have you people looked into the possible use of boron propellants in any large degree for rocket or basic missile development?

Dr. SCHECHTER. Our major effort has been to explore the chemical aspects of these programs. In recent months we have put more effort into the propellant side of the programs and intend to work more on the propellants in the future, as distinguished from the chemical side.

Mr. FULTON. Don't you think it would be wise when the major programs, say the turbojets, the afterburners, and the ramjets, have not been followed through by the military services, that there may be a good field for the use of boron propellants and these high-energy propellants in the rocket and missile field; that is, both civilian and military? Don't you think there is an adequate field that should be explored by NASA and the various agencies that are working in this field?

Dr. SCHECHTER. Yes, we think there is a lot of potential in this field.

Mr. FULTON. So your advice, then, would be to keep probably both scientific teams together, both in the Olin Mathieson Corp. as well as in your company, and I might add, in the other companies and universities who have had some contact with these research problems; in other words, to save that asset for our American people in scientific research, both military and civilian?

Dr. SCHECHTER. Yes. We feel quite strongly that this investment will be utilized in the future and that it shouldn't be broken up at this time and reassembled later at much expense and much embarrassment both to the Government and to the companies involved.

Mr. FULTON. And on that basis, then, you would conclude as I would, that this is not a mistake, because we do have the assets, with no dollar tags on them, the scientific teams, and the research underway in these high-energy fuels. This is just one particular step. We do have the possibility, if we look ahead to the needs of space travel and military uses, of quite an extensive field where we should be making developments in the United States; is that not right?

Dr. SCHECHTER. That is right.

Mr. FULTON. I have one other question and then I am through. In the context of the race or the competition with Russia, one of the places where we have not been keeping up in the United States is

on the size of the vehicles which we have been launching. You see we haven't had the size of payload the Russians have had and one reason has been that we have not had the advances, probably, on fuels, nor the development of the high-specific impulse that they may have been getting through some fuel that we don't know about. And if we can reduce the fuel load we can greatly increase the payload if we get a high-specific impulse; is that not right?

Dr. SCHECHTER. That is right.

Mr. FULTON. Do you feel that is a worthwhile field of endeavor? Would your company like to proceed with the development of these high-energy fuels of various kinds and varieties for which there is a great demand in the space field, both military and civilian?

Dr. SCHECHTER. Very definitely.

Mr. FULTON. Thank you. That is all.

The CHAIRMAN. Mr. Teague.

Mr. TEAGUE. No questions, Mr. Chairman.

The CHAIRMAN. Mr. Karth.

Mr. KARTH. Doctor, when was the Callery Co. organized?

Dr. SCHECHTER. 1948.

Mr. KARTH. What was your chief interest or chief product at the time it was organized?

Dr. SCHECHTER. Boron compounds. More specifically, the boron-hydride materials useful for fuels.

Mr. KARTH. When was your first Government contract?

Dr. SCHECHTER. Our parent concern, Mine Safety Appliances, had the first contract which started in late 1946 or early 1947.

Mr. KARTH. Would you restate that?

Dr. SCHECHTER. The first contract was in late 1946.

Mr. KARTH. Before the company was organized?

Dr. SCHECHTER. Parent company did the early work and Callery was established in 1948 to handle this work in the boron field.

Mr. KARTH. So Callery, insofar as this field is concerned, was born primarily as a result of Government contracts; is that correct?

Dr. SCHECHTER. Yes.

Mr. KARTH. And I suppose your company was aware at the time that whatever investment they made would be speculative, insofar as the research and development was concerned?

Mr. FULTON. Hardly that.

Mr. KARTH. Now just a minute.

Well, let me ask you this, Doctor: Was your company not aware of the fact that when they got involved in an R. & D. program it was a speculative program?

Dr. SCHECHTER. Yes. Our parent concern, Mine Safety, has done a lot of research over a long period of time and recognized this. They felt this particular field had promise. It was a field that had been explored very little and showed a lot of promise, both militarily and commercially.

Mr. KARTH. What was the investment of your company in dollars, as close as you can recall, prior to the first Government contract?

Dr. SCHECHTER. I would like Mr. Arch Miller to answer that question.

Mr. ARCH MILLER. The initial capital contribution was around $2.5 million.

Mr. KARTH. That is all, Mr. Chairman.

Mr. FULTON. Would you yield to me on your point just a minute?

The CHAIRMAN. Let me go around and then we will come back to you.

Mr. Hechler.

Mr. HECHLER. On page 13 you refer, Dr. Schechter, to claims and costs incident to the termination of the program that you say will no doubt run into millions of dollars. Frequently Members of Congress are accused of kind of throwing around figures. I know there is difficulty in perhaps pinning this down, but could you define with a little more preciseness what this figure is likely to amount to, or what the considerations are which will govern its change?

Dr. SCHECHTER. I will let Mr. Arch Miller answer that.

Mr. ARCH MILLER. As you can well realize, the terminations have hit us with a great deal of suddenness. What all is involved here, moneywise, we do not know. This is under review and evaluation now by our public accounting firm and by our legal firm.

Mr. HECHLER. Would you care to give an upper and lower limit?

Mr. ARCH MILLER. I have no idea.

Mr. HECHLER. Simply to say millions of dollars, that could be $100 or $50 or $10 or $5 million.

Mr. ARCH MILLER. The matter has not been evaluated even to that extent at this time.

Mr. HECHLER. Have you had any discussions with the military about settlement of contracts?

Mr. ARCH MILLER. None.

Mr. HECHLER. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Daddario.

Mr. DADDARIO. We have been talking about what might be done with the plant now that you have received this telegram which would terminate your contracts. The thought that comes to my mind is, now that you have had this experience, now that all these moneys have been expended, people have bought homes, have been dislocated from one community to another, and there is all this hardship which is involved, both present and prospective, what might have been done, taking the benefit of your experience that you have now, to terminate this before so many of these elements were finally brought to such a strong conclusion to cause these hardships?

Dr. SCHECHTER. Well, the thing that caused this finally, I think, as presented yesterday by the Air Force, were developments in the B-70 program that obviated the necessity for these fuels. If we accept this explanation, this is the way R. & D. goes. We have to accept this sort of thing.

Mr. DADDARIO. I do not have the report before me, but it said the developments in the B-70—I think the words were, had been improved to the point where such need of fuel becomes less critical, so it means there is still a critical need for long-range fuels of some type.

It may be that it goes into another area but the thing that bothers me most here is that there are certain problems which the Navy set forth yesterday, logistical and otherwise, the handling of this particular product, and the fleet usage of it.

These themes would seem to me to have arisen earlier from an R. & D. program and I just wondered if, with your experience, you

might not say now that if this program had been brought before a board which was a completely objective one and they said, "Now, this is what we are going to go into, this is what it is going to cost, this is the kind of product we will have," and have this objective board come to some conclusion and offer some suggestion, that perhaps at the R. & D. stage this thing might be terminated before all these extra millions of dollars had been spent in production.

Dr. SCHECHTER. We understand there were reviews on this but we do not have this information, the results of these reviews, available. I do not believe we can really comment on that.

Mr. DADDARIO. Your point now is that there have been reviews over the course of time. You do not have any information concerning what those reviews amounted to. You went along working hard on this program and developing your team. As I understand your previous testimony, until a week or two ago you had no real idea that this project was being terminated and that suddenly it was.

Therefore, would you not think that it might have been a good idea if, while these reviews were being handled by whatever committees, groups, or persons, that it might have been a good idea if you people had been allowed to participate in the benefit of those reports and reviews so that you might have known a little bit better when you were going?

Dr. SCHECHTER. This would have helped, certainly.

We feel the program should not have been terminated but, rather, rechanneled on a different basis.

Which is what we are recommending here; that is, a holding action be taken so that further study can be made of these things and not jettison the whole program before we see what can be salvaged out of it.

Mr. DADDARIO. I can well understand your feeling in that regard and the thing that bothers me, as I look over many of these research and development programs, is that while people like you have put together teams and groups to perform certain functions and that they do perform them, and they are well-intentioned people and skilled in their work, somebody somewhere is going off on another tangent, and somehow or other these people are never brought together. I think this might be one of the problems.

Do you not agree that that might be the case and that there should be some cohesive plan to put these ideas together so that they are not off in fields by themselves?

Dr. SCHECHTER. Well, we certainly do not think that the program as a whole was a mistake.

Naturally, being human beings, we would like to be in on the decisions as far as possible. But, as I stated several times, we feel something can still be made out of this if the proper steps are taken in time. And that to us is in the next month or 6 weeks.

Mr. DADDARIO. Although you have not said so exactly, it would seem to me that the indications are that you do not agree that this project ought to be terminated.

It does not seem to me either that you have given as yet, even, from what you have said, any real indication as to why this program has been terminated or what will take its place. You have said, however,

that you do not feel that you are qualified militarily; and that is about as far as you go.

Isn't that about the size of it at the moment, sir?

Dr. SCHECHTER. What has happened is that one aspect of the hardware program has been canceled and that the others are not in a state where they can pick up the whole program.

So, we feel this program should be reoriented and a skeleton force be kept that can carry on and utilize the vast amount of knowledge that has been collected.

Mr. DADDARIO. You believe it would be a loss if this were not done and if the Government just went around and tried to sell these plants off to whomever else might use them and destroy this whole movement that is taking place?

Dr. SCHECHTER. That is right.

Mr. DADDARIO. That is all.

The CHAIRMAN. I have been asked to ask you this question: How large a payroll is affected down there in Muskogee, Okla.?

Dr. SCHECHTER. About $220,000 a month in Muskogee.

The CHAIRMAN. You could not testify as to New York?

Dr. SCHECHTER. No, sir.

Mr. TEAGUE. Is that the original payroll or present payroll?

Dr. SCHECHTER. Payroll for the full staff.

Mr. TEAGUE. It is down now to approximately what?

Dr. SCHECHTER. About 60 percent of that.

The CHAIRMAN. Is that the operating payroll or the construction payroll?

Dr. SCHECHTER. Operating payroll.

The CHAIRMAN. Mr. Moeller.

Mr. MOELLER. No questions.

The CHAIRMAN. Mr. King.

Mr. KING. Mr. Chairman, I think the time is pretty well gone. There are some questions I could ask.

Mr. FULTON. The question comes up on your contracts with the Government and your opportunity to have a chance to see these reviews or discuss with Government officials. That has brought up an inference as to the possibility of your having any former people from the military, or the Department of Defense working for your company.

I want to know whether you were dealing at arm's-length with the Government in all these contracts, first; and then secondly, I would like to have you put in the record any retired generals or admirals or anybody like that you might have employed. Would you please comment on that?

Dr. SCHECHTER. We have no retired military people on our payroll directly. We have a consultant who works for us aproximately one-fourth time who is a retired Navy captain.

Mr. FULTON. He is on a consultant basis, is he not? He is not employed by your company directly?

Dr. SCHECHTER. Right.

The CHAIRMAN. Who is that?

Dr. SCHECHTER. Mr. Joseph Gardiner.

Mr. FULTON. What kind of consulting does he do?

Dr. SCHECHTER. He helps us in our activities in trying to promote our products and gives us guidance on where they might be used and what parts of the Government might be interested in using these materials.

Mr. FULTON. But you have no overloaded staff of technical people, people from the Department of Defense or the military, such as has been brought out by the other subcommittees.

You are dealing at arm's-length with the Government in your dealings and your contracts?

Dr. SCHECHTER. Yes, sir.

Mr. FULTON. So you are acting as a contractor doing what the Government wants on the boron fuel program and carrying out the mandates of the contracting officers within the contract provisions they lay down, right?

Dr. SCHECHTER. Right.

Mr. FULTON. Has your company met the price and cost requirements that the Government has laid down for the fuel that has been purchased?

Ask your accountant there. You have conformed to the contracts the Government has given you, both as to price and performance and quality, right?

Mr. ARCH MILLER. Right.

I would like to elaborate on that a little bit if I may.

At our plant at Lawrence, under a production contract we encountered some problems in startup, but the last month of full operation there, we slightly exceeded quantities we said we would get out of that plant and we did hit the target costs.

Mr. FULTON. That is on page 14 of your statement—

in the final month of full operation at Lawrence, Kans., production exceeded that set forth in Callery's original bid proposal and the cost per pound originally quoted was met—

so that you have fully performed both as to price, quantity, and quality, on all Government contracts that you have been given; is that not right?

The CHAIRMAN. May I suggest you put that in the record? We have this proposition: We have Olin Mathieson here and they are entitled to be heard, too.

Now, this afternoon, after lunch, we are going to be pretty busy on the floor and I think——

Mr. FULTON. This is my last question.

Dr. SCHECHTER. That is essentially true.

Mr. FULTON. Thank you.

The CHAIRMAN. Thank you very much, sir, and the staff for helping us. We appreciate your valuable testimony. At this time we will hear Mr. D. J. Carroll Copps, vice president and general manager of the energy division of Olin Mathieson Chemical Corp. He is accompanied by William C. Foster, corporate vice president, and Dr. L. Kermit Herndon, divisional vice president and George Siegelman, director of operations for liquid fuels.

STATEMENT OF D. J. CARROLL COPPS, VICE PRESIDENT AND GENERAL MANAGER OF THE ENERGY DIVISION; ACCOMPANIED BY WILLIAM C. FOSTER, VICE PRESIDENT; DR. L. KERMIT HERNDON, DIVISIONAL VICE PRESIDENT; AND GEORGE SIEGELMAN, DIRECTOR OF OPERATIONS FOR LIQUID FUELS, OLIN MATHIESON CHEMICAL CORP.

Mr. COPPS. Mr. Chairman, I have a prepared statement here.

The CHAIRMAN. We have gone into the general proposition there and we would appreciate it if you would proceed with your prepared statement, and then we would like to know specifically about your company, how you are affected and what your own reaction is.

Mr. COPPS. Mr. Chairman and members of the committee, my name is D. J. Carroll Copps.

I am a corporate vice president and general manager of the energy division of Olin Mathieson Chemical Corp. I joined Olin Mathieson on June 1, 1958, as the operating head of the corporation's energy division and am accompanied at this hearing by Mr. William C. Foster, also a corporate vice president of Olin Mathieson. Mr. Foster joined the corporation in 1955 and has been from time to time associated with various phases of this program.

In addition, accompanying me are Dr. L. Kermit Herndon, divisional vice president and technical director for the energy division, and Mr. George Siegelman, director of operations for liquid fuels.

A. RESEARCH AND DEVELOPMENT

Olin Mathieson's participation in the high-energy liquid fuels program commenced with a research and development project with the Navy in March, 1952, under contract NOa(s) 52–1023 on a cost-reimbursement basis. This was known as Project ZIP. This research and development contract was supported by a facilities contract authorized in 1953 by the Navy, designated NOa 53–120.

Although this work was performed in laboratories owned by Olin Mathieson at Niagara Falls, N.Y., the facilities contract provided for the procurement of additional laboratory and pilot plant equipment on a cost-reimbursement basis (without fee) for the use of Olin Mathieson and its subcontractors.

The research and development program initiated by the Navy Department has been continued by the Air Force, and is proceeding today on a substantially curtailed basis in connection with more advanced high-energy liquid fuels under contract AF 33 (600)–33920, which is on a cost-plus-fixed-fee basis.

The objectives of the VIP program were stated to us by the Bureau of Aeronautics, Navy Department, in a secret document RS–1 dated May 22, 1952, relating to contract NOa(s) 52–1023.

An unclassified statement of these objectives is that Olin Mathieson was to do chemical research to find new fuels with appreciably higher heat content per pound than conventional hydrocarbon fuels and to determine their chemical and physical properties, handling

characteristics, and adaptability to existing engines. We were expected to develop processes in pilot plants, to have the fuels derived therefrom tested, and to develop design criteria for full-scale plants for producing these fuels. Document RS–1 stated that "this fuel is needed in the shortest possible time."

Within 2 years Olin Mathieson chemists produced in the laboratory a chemical which was adopted by the Navy and later by the Air Force as a fuel that met their specifications. This fuel was called HEF–3. We were engaged in the development of production processes for this fuel as well as working on the interim test fuel HEF–2 when the Air Force assumed cognizance of our program on July 1, 1956.

The objectives for our Air Force Contract AF33(600)–33920, referred to above, stipulated the properties of the HEF–3 fuel as the desired basis for continued research and development and pilot plant programs. This was in anticipation of the design, engineering, and construction of one or more full-scale plants for the production of this fuel and more advanced fuels based on boron chemistry.

Olin Mathieson has also been working under Air Force sponsorship on the development of a boron-based fuel of even higher heat value, which we have labeled "HEF–4" and another of high temperature stability of increased heat value per gallon labeled "HEF–5." We have also been working under other Air Force contracts looking toward the utilization of boron chemicals as fuel binders in solid propellants, which work is continuing.

B. INTERIM TEST FUEL

The second phase of the program was on the production of limited quantities of an interim high-energy liquid fuel required for test purposes in connection with the engine development program sponsored by the Navy and the Air Force.

In June 1954, Olin Mathieson submitted to the Navy Department a proposal for an interim production plant program which was embodied in document NF–1338 dated June 1954 and transmitted by letter serial M 261, dated July 6, 1954.

Subsequently, Contract NOa56–042 was executed covering the design, construction, and the equipment of an interim production plant to be located at the site owned by the Government near Lewiston, N.Y., formerly known as the Lake Ontario Ordnance Works. This contract was dated June 6, 1956, and provided for reimbursement to Olin Mathieson of the costs incurred in connection with the services performed but without fee. On April 30, 1957, Olin Mathieson entered into a contract with the Navy Department (NOa(s)57–773) calling for the production in the interim production plant on a cost-plus-a-fixed-fee basis of a limited quantity of high-energy fuel known as HEF–2 pursuant to stipulated specifications.

The interim production plant has been in continuous operation since August 1958 and has produced HEF–2 fuel at a rate in excess of its design capacity and at a cost substantially below the originally estimated cost for the finished product. This plant, under its reduced rate of operation, is scheduled at the present time to be shut down at the end of October 1959.

C. PILOT PLANTS

As the research and development program progressed, and in view of various breakthroughs in chemical technology which occurred, representatives of the Navy and the Air Force approached us regarding the design and construction of a full-scale plant to produce high-energy liquid fuels.

Accordingly, several small-scale pilot units were installed and operated under the research and development programs. These units permitted the development of technical information relating to specific steps in the process planned for the full-scale production plant contemplated by the Air Force. In addition, Olin Mathieson recognized that for the purpose of developing the technical data required for the satisfactory design, engineering and efficient operation, including startup, of a full-scale production plant, it would be necessary to build and operate a partially integrated pilot plant unit which could use commercially available process equipment.

A proposal covering such a plant was made by Olin Mathieson to the Air Force during the early part of 1956. However, the Air Force had no funds available to finance the cost of the proposed plant. Nevertheless, and in view of our understanding of the urgency of this program, an agreement was reached under which the company used its own funds for the design and construction of the plant and received from the Air Force a contract on a fixed-price basis calling for the production of an initial stated quantity of high-energy fuel meeting stipulated specifications.

The CHAIRMAN. Mr. Copps, I am very sorry, but that is the second call from the floor.

Gentlemen, there is no use coming back before lunch. We could meet here at 2 o'clock, if that would be all right with you, and we could finish up.

Olin Mathieson is the last witness on this particular inquiry that we have set up, with the exception, later on, of a Department of Defense witness.

If that is all right, we will recess until 2 p.m.

(At 11:30 a.m. the committee recessed until 2 p.m.)

AFTERNOON SESSION

The CHAIRMAN. Gentlemen, as you know, the housing bill is on the floor now and, much to my surprise, they completed the general debate earlier by an hour than I thought they would.

As a result of it we are going to be cut down in the attendance this afternoon.

And I think it would be preferable to go ahead and complete the testimony of Olin Mathieson.

(Further statement off the record.)

The CHAIRMAN. If you agree with me, sir, we will go ahead with you.

Mr. COPPS. Right.

The CHAIRMAN. The others will come in from time to time, but we will have the record completed. The press will have an opportunity to get your statement and the members of the committee will have an opportunity to review it in printed form later on.

Mr. COPPS. Yes, sir.

The CHAIRMAN. So let us take up where we left off and complete your general statement.

STATEMENT OF D. J. CARROLL COPPS, OLIN MATHIESON CHEMICAL CO.—Continued

Mr. COPPS. Mr. Chairman, I had covered research and development and the interim test fuel and had just gotten into pilot plants. I would like to continue, and for the sake of continuity, I will start at the "pilot plant operations" on page 4.

The CHAIRMAN. All right, sir.

That is what page?

Mr. COPPS. Page 4.

The CHAIRMAN. All right.

Mr. COPPS. As the research and development program progressed, and in view of various breakthroughs in chemical technology which occurred, representatives of the Navy and the Air Force approached us regarding the design and construction of a full-scale plant to produce high-energy liquid fuels.

Accordingly, several small-scale pilot units were installed and operated under the research and development programs. These units permitted the development of technical information relating to specific steps in the process planned for the full-scale production plant contemplated by the Air Force. In addition, Olin Mathieson recognized that for the purpose of developing the technical data required for the satisfactory design, engineering, and efficient operation including startup, of a full-scale production plant, it would be necessary to build and operate a partially integrated pilot-plant unit which could use commercially available process equipment.

A proposal covering such a plant was made by Olin Mathieson to the Air Force during the early part of 1956. However, the Air Force had no funds available to finance the cost of the proposed plant.

Nevertheless, and in view of our understanding of the urgency of this program, an agreement was reached under which the company used its own funds for the design and construction of the plant and received from the Air Force a contract on a fixed-price basis calling for the production and delivery of an initial stated quantity of high-energy fuel meeting stipulated specifications. This initial contract contemplated that the cost of this pilot plant would be included in the unit price of the product and be amortized over a period of 5 years.

However, the quantities called for under this initial contract were wholly inadequate to completely amortize the cost of the facility, and we expected that additional contracts would be forthcoming.

Olin Mathieson completed the production and delivery of the entire quantity of material called for by this contract by the spring of 1959. Due to the fact that no significant additional orders were received, Olin Mathieson did not even recover the amortized cost of the plant.

In addition, during the operation of this plant, Olin Mathieson spent a very substantial amount of its own funds in order to gain the technical information necessary for the design, engineering, and efficient startup of the full-scale production plant to be built by them for the Air Force. The expenditure of company funds in this opera-

tion also contributed materially to the efficient startup of the interim production plant and resulted in a substantial reduction in the cost of the material produced at that plant.

Following the completion of deliveries in the spring of 1959, the company-owned pilot plant was shut down, decontaminated, and placed in cold standby. The substantial financial loss suffered by the company was reflected in the company's financial results for 1958.

D. PRODUCTION

In February 1957, we executed a facilities contract with the Air Force designated AF33 (600)–33060 covering the design, engineering, and construction of a full-scale plant for the production of high-energy liquid fuels.

This contract was on a cost-reimbursement basis but without fee, and the plant was also located on Government-owned land formerly known as the Lake Ontario Ordnance Works. It was completed last spring at a cost of approximately $45 million. Under Air Force contract AF33 (600)–35077, executed in June 1958, Olin Mathieson undertook the production, on a cost-plus-fixed-fee basis, of a specific quantity of high-energy liquid fuels at this plant in accordance with the specifications stated in the contract. At the time of the termination of this contract by the Air Force on August 10, 1959, the plant was in process of startup.

This plant is presently in standby condition——

Mr. Chairman, I would like to explain in here this standby condition. This plant is not producing, but is being maintained for protection of the valuable plant and materials that are in that plant.

Then continuing—and discussions are actively under way with Air Force representatives regarding the disposition to be made of the plant, including the disposal of active chemical materials in the process equipment.

This Air Force production plant is a highly specialized one designed specifically for high-energy fuels and our entire effort has been devoted to process development for this purpose. In our opinion, there is no commercial requirement for these fuels.

E. PERSONNEL

In carrying out the high-energy fuels program, Olin Mathieson assigned from its research and engineering staffs and recruited from outside sources a substantial number of highly qualified technical personnel as well as operating people. We presently have a total of over 1,400 people—approximately equally divided between professional and operating-administrative-clerical—on this program, of whom 752 are in the full-scale production plant, 83 in the interim production plant, 103 on pilot plants, and 127 are in research and development activities. The remainder are clerical and administrative personnel. Termination and curtailment of Air Force contracts, already effected, affects over 1,000 employees. While Olin Mathieson is making efforts to plan the integration of these people in its operations at other locations, it must be appreciated that this is practically an impossible task.

I am sure, Mr. Chairman, that you and the members of the committee appreciate that segments of this statement are related to classi-

fied material and for this reason portions of my statement have necessarily been general in nature.

This concludes my formal statement. My associates and I will be glad to try to answer any questions you may have.

Mr. Chairman, in addition to my prepared statement and, as a result of the testimony presented to the committee for the past 2 days, I would like to make the following further remarks.

(1) I would like to make it abundantly clear to this committee that Olin Mathieson's work in the high energy fuel program is an integral part of the corporation's overall activity. We have assigned many of our key personnel, some of them for as long as 7 years, to this program, and it has never been considered a marginal activity of the corporation.

(2) Olin Mathieson's participation in the high energy fuels program dates back as far as 1946, when we initiated work on the production of anhydrous hydrazine, of which we are still the only major producer. This was the forerunner of our company's active participation in the field of boron chemistry. We do not minimize the contributions that Callery Chemical Co. has made in this field, which we have shared prior to our participation in this particular phase of high energy fuels.

We are, however, intensely proud of what our many skilled scientists and engineers have contributed to this field and subsequently these developments have been made available to Callery.

During the period of our participation in this program, we have produced over 250 tons of satisfactory material which is over 90 percent of the total of such produced.

All of the NACA test work was done with Olin Mathieson-produced fuels.

(3) For the record, we would like to say we question the statement made this morning as to the relative cost of producing diborane in the two plants.

This is a factual matter which can be and undoubtedly will be determined by appropriate authorities.

That completes it.

The CHAIRMAN. Thank you very much, sir.

I would like to ask you a few questions while you are here.

Now, of course, Olin Mathieson is a national concern, that is well-known for its activity throughout the country.

You have different branches and different departments, I am sure.

Mr. COPPS. Yes, sir.

The CHAIRMAN. In different types of activity.

You have a heavy investment, though, in this particular project. What is your total investment, do you think?

Mr. COPPS. When we entered this at the request of the Navy, we gave serious consideration to setting up a subsidiary and carrying the work on under that, but for many reasons we decided to carry it on as a corporation.

We do not break out the exact figures, but I would be glad to give you relative figures.

The CHAIRMAN. All right, relative figures would be sufficient.

Mr. COPPS. We have an investment in this high energy area alone of around $25 million.

We have had losses, after taxes, for the overall program, since March of 1952 to last December, of approximately, something over $4 million. These losses have been included in our year-to-year statements, with writeoffs of last year.

The CHAIRMAN. How much, you would say?

Mr. COPPS. Something over $4 million in losses, after taxes.

The CHAIRMAN. $4 million in losses?

Mr. COPPS. After taxes.

I might add——

The CHAIRMAN. On this program?

Mr. COPPS. On this total program.

I might add that the first—since March of 1952, through December of 1955, all the R. & D. work done on this program was done without fee. Normally we get approximately a 7-percent fee. But we waived that for that period of years.

The CHAIRMAN. Well, I would say 7 percent for architect and engineering is about the percentage which the Army Engineers charges the several departments in construction work generally, for the Government, something around 7 percent, isn't that right?

Mr. COPPS. This was just research and development. Not on construction. Not engineering work.

The CHAIRMAN. This is merely research and development.

Mr. COPPS. Right.

The CHAIRMAN. Seven percent.

Mr. COPPS. Yes, sir.

The CHAIRMAN. Now, you have employed on this project 1,400 people, you say?

Mr. COPPS. Yes, sir.

The CHAIRMAN. But you also say that the shutdown will deprive 1,000 of those 1,400 of their jobs?

Mr. COPPS. Yes, sir.

The CHAIRMAN. Is that right?

Mr. COPPS. Yes, sir.

The CHAIRMAN. Where are the other 400 going?

Mr. COPPS. We have in this program R. & D. work, which is being cut back. We have the IPP plant, that is the south plant, presently known as the south plant, which is in production, and we have been told will run out in October. And then plus the 750 in the north plant makes up the total.

The CHAIRMAN. Well, now, your 400 that you are going to be able to retain for the present—will they be there indefinitely, or will it merely be temporary?

Mr. COPPS. They will be in our organization, we expect and hope, permanently.

The CHAIRMAN. To absorb them in some way in your organization.

Mr. COPPS. Well, we have other programs which we hope will continue.

The CHAIRMAN. Of course, when you handled this work for the military, you naturally were deprived of the opportunity of handling other work that you might have become interested in, isn't that true?

Mr. COPPS. That is correct.

The CHAIRMAN. So you probably turned down work that you otherwise would have had?

Mr. COPPS. Yes, sir.

The CHAIRMAN. Because of this program.

Now, when was the first notice that you had, that this product that you were making was not suitable—rather, I will put it this way, was not going to be needed by the U.S. Government?

Mr. COPPS. We got indications, normally at the working level of our group and the Air Force group, around the 1st of August, that there might be some cutback. We were ready to put this plant on full production—not full production, but output of production, on Wednesday, I think it was August 5, approximately. And we were asked by the contracting officer not to start that up and give them a few days for consideration.

We got official notice of cancellation of the production contract only on August 10, with specific instructions to carry out certain work at the direction of the local contracting officer.

The CHAIRMAN. Now, let's see if I have the situation correct in my mind.

You received the first idea that the program might be cut back about August 1?

(Mr. Copps nods.)

The CHAIRMAN. And then you received the final notice to cut back the program 12 days later.

Mr. COPPS. On the 10th.

The CHAIRMAN. On the 10th. Ten days later. So you actually knew about the possibility that the program might be cut back only 10 days before it was actually determined to cut it back.

Mr. COPPS. Yes.

The CHAIRMAN. You had no idea that there was a possibility that the investigation was being made to cut back the program?

Mr. COPPS. Only through the lower level organizations, but nothing official.

The CHAIRMAN. Now, they found nothing wrong with your work, did they?

Mr. COPPS. Not to our knowledge.

The CHAIRMAN. The product was being produced according to specifications, wasn't it?

Mr. COPPS. Our product has met all specifications and we have produced at lower than the cost estimated in the contracts.

The CHAIRMAN. What does it cost——

Mr. COPPS. I better explain.

The CHAIRMAN. Yes.

Mr. COPPS. The north plant is a cancellation. We have not produced 1 pound out of that plant. We were ready to start that production on Wednesday, the 5th.

The CHAIRMAN. When was the north plant completed?

Mr. COPPS. Well, it had just been broken in and different areas started up since May.

The CHAIRMAN. It was broken in, and areas started up since May. But you have not produced a pound of propellant out of it?

Mr. COPPS. Each area has been operated to be tested out, and on Wednesday night we were to put the throughput, start that.

The CHAIRMAN. And you got the notice when?

Mr. COPPS. We got the notice on the 10th, Monday.

The CHAIRMAN. Monday.

Mr. COPPS. We were asked verbally not to start up.

The CHAIRMAN. Two days after it was to start to go in production.

Mr. COPPS. No; Wednesday when we anticipated going in, we were requested verbally not to start up.

The CHAIRMAN. But that was on the 5th?

Mr. COPPS. Yes, sir.

The CHAIRMAN. That you were asked verbally.

Mr. COPPS. Yes, sir.

The CHAIRMAN. But you got the notice on Monday, the Monday before you were to go in production on Wednesday.

Mr. COPPS. No, the Monday following the Wednesday.

The CHAIRMAN. Oh, the Monday following the Wednesday.

Mr. COPPS. Right.

The CHAIRMAN. You were supposed to go in production.

So were you to receive no notice, you would have been in production 3 or 4 days anyway?

Mr. COPPS. Yes, sir.

The CHAIRMAN. Now, that north plant you referred to: What investment is that?

Mr. COPPS. That is $45 million construction cost.

The CHAIRMAN. Is that the Government-owned plant?

Mr. COPPS. That is Government-owned plant.

The CHAIRMAN. Now, what is its status as of this hour?

Mr. COPPS. We are waiting instructions as to what to do with these areas that had been broken in with valuable material in each area.

The CHAIRMAN. You have not started the use of the plant?

Mr. COPPS. Just those areas have all been worked out separately, but no integrated operation.

The CHAIRMAN. Well, are you continuing with those separate operations?

Mr. COPPS. We have to, to protect the property and the chemicals that are in there, until we get instructions as to what they want done.

The CHAIRMAN. You are waiting, then, on further instructions as to whether or not to put the plant totally in standby shape?

Mr. COPPS. Yes, sir.

The CHAIRMAN. Have you been told unofficially what those instructions are going to be?

Mr. COPPS. No, sir. We have had two or three—we have been requested to give certain information so they can make some judgment, but we do not know what their decision is going to be.

The CHAIRMAN. So you haven't released your employees or disintegrated your organization yet?

Mr. COPPS. We can't until we are told to proceed.

The CHAIRMAN. Now—and that north plant employs about 750 people?

Mr. COPPS. Yes, sir.

The CHAIRMAN. What about the plant you built yourself? What has happened to it?

Mr. COPPS. That plant was shut down because of lack of orders, about 3 months ago, roughly——

Mr. SIEGELMAN. May 1959.

The CHAIRMAN. That was a plant that was built on the contract that you would be given orders in order to amortize the cost of it.

Mr. COPPS. That was our understanding.

The CHAIRMAN. Well, do you consider that a breach of contract, then?

Mr. COPPS. We have no breach of written contract.

The CHAIRMAN. You have no written contract?

Mr. COPPS. We had a written contract, under which we have produced the quantities called for.

The CHAIRMAN. And you have produced the quantities called for in your written contract?

Mr. COPPS. Yes, sir.

The CHAIRMAN. But that does not amortize the cost of the plant?

Mr. COPPS. No, sir.

The CHAIRMAN. What is your investment still in that plant?

Mr. COPPS. We charged it off in this loss of $4 million that I gave you.

The CHAIRMAN. Would you say the cost was $4 million—the loss $4 million, in it?

Mr. COPPS. It was $8.5 million before taxes.

The CHAIRMAN. The plant cost you $8.5 million?

Mr. COPPS. Isn't that approximately right?

Mr. SIEGELMAN. Yes.

The CHAIRMAN. That is more than our records indicate the cost.

Mr. COPPS. Just a minute.

Will you explain it?

I can't draw out the exact difference in the start-up cost and the engineering cost and the actual plant cost here today. I do not have those figures readily available. I can furnish them to you.

The CHAIRMAN. Could you furnish us the exact cost of plant?

Mr. COPPS. Yes, sir.

(The information requested is as follows:)

The actual facility cost to Olin Mathieson of the company-owned plant was $6,215,305. The $4 million after tax loss on the overall program stated to the committee included the writeoff of the company-owned plant down to residual value and engineering and experimental work in support of the North plant for which we were not reimbursed.

The CHAIRMAN. But you do know that your loss on that transaction is around $4 million?

Mr. COPPS. After taxes, yes, sir.

The CHAIRMAN. And you do know your investment on that, that is your own company investment, is around $25 million on this project?

Mr. COPPS. All of our investments, working capital, and so forth, is $25 million in that particular area.

The CHAIRMAN. Now, have you any idea or any recommendations as to how these plants may be used other than the use that they are presently being employed for?

Mr. COPPS. We are hopeful that this requirement of fuel will ultimately show up and be a requirement. As we see it today, there is no use for these fuels commercially, as I stated.

The intermediates or the end product, I mean. Until someone tells us there is a requirement, we see no use for operating these plants.

The CHAIRMAN. Is the plant adaptable to any other purpose?

Mr. COPPS. We have been asked to make a study of that, and we will in the very near future. We have not done any work on that to date.

The CHAIRMAN. When do you think you will complete that study?
Mr. COPPS. 30 days?
Mr. SIEGELMAN. I guess around 60 days.
Mr. COPPS. Around 60 days.
The CHAIRMAN. When you do complete it, we would like to get your recommendations in reference to the future use of the plant.
Mr. COPPS. All right, sir.
The CHAIRMAN. If that would be acceptable with your company.
Now, that takes care of two of the plants—the $45 million plant and the one you built, that you said cost a little better than $8 million. Aren't there other plants up there?
Mr. COPPS. The so-called south plant—the original Navy plant.
The CHAIRMAN. Yes. What is the investment in that?
Mr. COPPS. That was shown——
Mr. SIEGELMAN. About four and a half.
Mr. COPPS. $4½ million.
The CHAIRMAN. Is that a Government-owned plant?
Mr. COPPS. That is Government-owned and is in operation today.
The CHAIRMAN. It is in operation today.
Mr. COPPS. And to the best of our knowledge will run through probably October.
The CHAIRMAN. How many people do they employ today?
Mr. COPPS. Approximately 100.
The CHAIRMAN. Are you operating it?
Mr. COPPS. Yes, sir.
The CHAIRMAN. For the Navy?
Mr. COPPS. No, for the Air Force.
The CHAIRMAN. For the Air Force?
Mr. COPPS. Yes, sir.
The CHAIRMAN. What is its production now?
Mr. COPPS. That is a restricted item, according to our contract.
The CHAIRMAN. All right. We will get it from the Air Force.
Mr. COPPS. Yes.
The CHAIRMAN. At any rate, it is operating to capacity?
Mr. COPPS. No, sir. It ran at 130 percent of capacity, but when the requirements were reduced, we were cut back to run it at something under capacity.
The CHAIRMAN. All right.
Mr. SIEGELMAN. 75 percent.
The CHAIRMAN. Are there any other plants involved, other than the north plant, the south plant, and the one you own?
Mr. COPPS. Only the small R. & D. plants.
The CHAIRMAN. What are they?
Mr. COPPS. They are there at Niagara Falls, doing work—some of them are still working.
The CHAIRMAN. Could you name those?
Mr. COPPS. They have no names.
The CHAIRMAN. Well, did you designate them?
Mr. COPPS. Can he answer that for me?
The CHAIRMAN. Sure.
Mr. SIEGELMAN. There are a series of pilot plants on which work was proceeding up to the curtailment. These plants that are being shut down are facilities to provide for alkylation, for pyrolysis, as we

call it. Those are the two major plants. There is no maintenance provided for other pilot plants as a part of the backup for the north plant, engineering design work.

The CHAIRMAN. These two additional plants you refer to, are they Government built?

Mr. SIEGELMAN. Yes, sir.

The CHAIRMAN. Government financed?

Mr. SIEGELMAN. Government financed.

The CHAIRMAN. What is the investment in those two plants?

Mr. SIEGELMAN. I would say approximately $600,000.

The CHAIRMAN. Now, do you have any contracts with other industries for R. & D. work, or any other work in connection with this project, or any contracts with universities or colleges outstanding at this time?

Mr. COPPS. We have no outstanding contracts with universities.

The CHAIRMAN. Callery testified it had some outstanding contracts that had been canceled. But you had none?

Mr. COPPS. No, sir.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. I want to congratulate the chairman. You have asked so many of the questions I am interested in. The point I am particularly interested in is what the scientific teams are, that are engaged in each of these companies. I notice on page 6 of your statement:

> We presently have a total of over 1,400 people (approximately equally divided between professional and operating, administrative, and clerical) on this program, of whom 752 are in the full-scale production plant, 83 in the interim production plant, 130 pilot plants, and 127 are in research and development activities. The remainder are clerical and administrative personnel.

Now, it says, "termination and curtailment of Air Force contract already affected over 1,000 employees."

Now, my question to you, just as it was to Callery, is, What is your scientific team, out of these figures? Is it 127 in research and development activities or is it more? Are they scattered through the professional and operating, administrative and clerical people, that are outlined above there in the parentheses?

Mr. COPPS. We have about 380 scientific personnel located at this operation.

Mr. FULTON. Now, of the scientific personnel, then, do I understand that number are assigned to this particular program, that is the boron high energy fuel program?

Mr. COPPS. Yes, sir.

Mr. FULTON. So that out of your total scientific personnel of the Olin Mathieson Corp., that number has been and still is employed directly on this type program that we in this country are interested in?

Mr. COPPS. Yes, sir; that is correct.

Mr. FULTON. And then on the bottom of page 6 and the top of page 7, where it states "1,000 employees are affected," how many of those are scientific employees that have been affected? I am looking for the erosion of scientific teams in this country. I am also looking at the employment of units the way Russia maintains them. So I am trying to get an estimate from you of the effect on your scientific team engaged in the boron fuel production program.

Mr. COPPS. Well, the only termination we actually have today is on the north plant, involving the 752 people, of which 100-and-some-odd are scientific personnel.

Mr. FULTON. Are they engaged in production or are they in research and development?

Mr. COPPS. They are actually in production, startup of the plant and improvement and getting everything in line. We have no definite cutback as yet concerning research and development. We have been talked to, that it probably is coming, on the pilot plant group and the research and development group. We think we know about what that is going to be, but we have nothing official.

Mr. FULTON. What is your estimate of it? Because we are interested in that on this committee. It is part of the scientific assets of this country.

Mr. COPPS. The reason we put this 1,000 is because of what we understand is coming. We understand that the IPP plant will be shut down in late fall. And we believe that the research and development activities are going to be reduced in the very near future, affecting about 30 people, roughly.

Mr. FULTON. Thirty people?

Mr. COPPS. Thirty scientists.

Mr. FULTON. But you actually have 127 on the scientific team, on page 6.

Mr. COPPS. We expect and have reason to expect that we are going to continue the rest of them in that area.

Mr. FULTON. But that would be working on other projects or on this boron production?

Mr. COPPS. It is on this boron.

Mr. FULTON. It would take the report of the Arthur Little, Inc., to make a recommendation on that. Because they would be subject to the results of that report; isn't that right?

Mr. COPPS. Yes.

Mr. FULTON. So that at this particular point the whole scientific team is in doubt as to whether it carries on or not?

Mr. COPPS. That is correct.

Mr. FULTON. And that has quite an effect on the morale of the scientific team, does it not?

Mr. COPPS. Yes, sir.

Mr. FULTON. Then you have said that—

> While Olin Mathieson is making every effort to plan the integration of those people in its operations at other locations, it must be appreciated this is practically an impossible task.

Could you give me the amount that refers to your scientific teams? You wouldn't be able to incorporate or integrate your scientific team into operations at other locations of your company, would you?

Mr. COPPS. We can't integrate all of them; no.

Mr. FULTON. What proportion would you think would have to be let go?

Mr. COPPS. Well, that is a very difficult question. But we hope to maintain two-thirds of them.

Mr. FULTON. So what number would that mean you would have to lose by this action of the Navy and the Air Force?

Mr. COPPS. Roughly 125 or 130 people.

Mr. FULTON. Now, are they in the order of chemists, physicists——

Mr. COPPS. Yes, and up. Masters and some Ph. D.'s.

Mr. FULTON. But they are in this chemical and fuel field and expert on high-energy fuel work, aren't they?

Mr. COPPS. Yes, sir.

Mr. FULTON. So that they could be used possibly on other NASA programs of high-energy fuel type?

Mr. COPPS. Yes, sir.

Mr. FULTON. Even though they are not going ahead with what you might call production of this particular type of boron high-energy fuel?

Mr. COPPS. That is correct.

Mr. FULTON. They would be available for experimental R. & D. work in most any high-energy fuel program would they not?

Mr. COPPS. Yes, sir.

Mr. FULTON. I mean they are rounded, and they are expert on that basis.

Now, then, you have stated that you have met the contract performance, both as to cost and quantity, as well as quality, haven't you?

Mr. COPPS. Yes; that is correct.

Mr. FULTON. So that both you and the Callery people have each conformed to whatever the requirements for this particular type of fuel, as well as the contracts that have been given to you, by either the Air Force or the Navy?

Mr. COPPS. So far as I know, we have; yes.

Mr. FULTON. Why do you feel that there was advance notice given to you prior to this August 10 date? It seems to me, as a matter of incidence, that the Callery Co. received notice of termination from the Navy on August 12, and you seem to have gotten yours August 10.

Do you see any correlation between those two dates?

Mr. COPPS. No; I can't comment on that.

Mr. FULTON. You see, that is the Navy in one instance, and the Air Force in another. And it all seems to happen at once to two companies.

Now, will you please comment as to that particular correlation or incidence of dates?

Mr. COPPS. I have no knowledge of why they would—why two different dates. I presume just two different services hadn't made a final decision.

Mr. FULTON. You see, they seem to have acted so independently and they seem to have had various reasons, though I must say the same 5-ton-a-day capacity on each program, and then suddenly a decision seems to have come down that goes into effect within 48 hours, right across the board, from these two Department of Defense agencies. There has been no testimony here of any joint action.

Now, I just thought you might have some comment as to that correlation of the incidence of those events.

Mr. COPPS. I was not in contact with the Navy, so I can't pass any comment on it.

Mr. FULTON. So you were dealing at arm's length both with the Air Force and the Navy?

Mr. COPPS. All of ours was with the Air Force, in this recent production. The North plant was strictly an Air Force plant.

The CHAIRMAN. Will the gentleman yield?

Mr. FULTON. I would be glad to.

The CHAIRMAN. As a matter of fact, the testimony shows that this had to be approved by the Defense Department; isn't that correct?

Mr. COPPS. That is our understanding.

The CHAIRMAN. Do you know of any other correlating agency that might have gone across the board between the Air Force and the Navy?

Mr. COPPS. I know of none.

Mr. FULTON. It certainly doesn't appear in the testimony that it was at the level of other than the Navy or the Air Force. It was solely at arm's length and it was a unilateral action by both the Navy and the Air Force, as far as you are concerned?

Mr. COPPS. That is correct.

Mr. FULTON. Is that not correct?

Mr. COPPS. Well, I believe from testimony yesterday, the only requirement for the last several months has been Air Force.

Mr. FULTON. Then, have you people estimated any amount, as has been asked here of the Callery Co. by Mr. Hechler, of West Virginia, as to the extent of your losses that you might have as a result of this action, when it is concluded?

Mr. COPPS. I have stated a few minutes ago that up until last December we had lost, after taxes, something over $4 million on the entire program since 1952.

Mr. FULTON. Yes; but I am saying now, suppose the termination becomes effective very promptly; have you people had any estimate as to what effect that will have on your operation?

Mr. COPPS. Our contract for the North plant, which is the only one we have termination on—the termination is covered in the contract. That is a cost-plus contract, and the termination is so written. We can't estimate shutdown costs because we haven't the faintest idea yet which step they are going to take.

Mr. FULTON. But you see, there has to be some calculation in advance as to the effect of these various actions, both as to the performance of contracts as well as the effect on the costs, the community, and also the effect on the taxpayers.

Would you submit a report for the record, because we have a rollcall, I guess, coming up. But if you would submit that for the record, I would like it.

Mr. COPPS. Yes, sir.

Mr. FULTON. Is that all right?

The CHAIRMAN. Yes, sure. If there is no objection, it is so ordered.

(The information requested is as follows:)

We have estimated the cost to completely empty the plant of all reactive and nonreactive chemicals. The costs for decontamination and cleanup of the areas which have been in operation are also included. The procedure to be utilized would be that normally employed where it is expected that a mothballing operation would be required to preserve the plant following the shutdown. It is expected that a cost of approximately $1 million will be incurred over a period of 3 months to shut the plant down and to place it in standby condition in accordance with our assumption.

Mr. FULTON. When you say "The company-owned plant was shut down and placed in cold standby," what do you mean by that?

Mr. COPPS. We decontaminated it and put it in position for us to make a study as to whether or not we could in any way find any use for it, before we sell it for scrap.

Mr. FULTON. That doesn't mean that you are maintaining it so that it could be used within a certain period?

Mr. COPPS. We put it in standby so if we make a decision within the next 60 days it is usable. If it is not, we will dispose of it.

Mr. FULTON. And that is 60 days from when?

Mr. COPPS. From about now, I would guess.

Mr. SIEGELMAN. That is right.

Mr. FULTON. What employees have you kept on there? I mean, what type of skeletal employee organization have you got?

Mr. COPPS. We have none there now.

Mr. FULTON. Then "a substantial loss suffered by the company was reflected in the company's financial results for 1958." Is that what you referred to when you explained the previous loss, of around $4 million?

Mr. COPPS. That is correct.

Mr. FULTON. But it has nothing in it of a reserve for losses on cancellation or laying up these plants in the future, does it?

Mr. COPPS. No, sir.

Mr. FULTON. Now, what is the difference between yourself and the Callery production in relation to the fuels? And I wish you would put that in the record. And then secondly, I would like to know; that is, have a statement put in the record, of what possible other uses these plants might be put to through cooperation with Government agencies on research and development in the high-energy fuel field or otherwise, or in the rocket and missile field. Would you supply that for the record?

Mr. COPPS. Yes, sir. We told the chairman that we had been requested for that information. As soon as it is available, we will furnish it.

Mr. FULTON. I would like to have it.

The CHAIRMAN. They have agreed to give it to the committee.

Mr. FULTON. I would like it in this record.

The CHAIRMAN. They have agreed. It is already in the record.

Mr. FULTON. All right.

(The information requested is as follows:)

OLIN MATHIESON CHEMICAL CORP.,
New York, N.Y., September 16, 1959.

Mr. CHARLES F. DUCANDER,
Executive Director, Science and Astronautics Committee, House of Representatives, Washington, D.C.

DEAR SIR: During my testimony before your committee on August 27, 1959, the committee requested for the record certain additional information concern-in Olin Mathieson's participation in the high-energy fuel program. Such additional information is submitted herewith in part, and the remainder, except for one item mentioned below, is being transmitted to the committee under separate cover because it contains material which is classified for security purposes.

The item excepted is the uses to which the Air Force plant might be put other than for the production of high-energy fuel based on boron. The studies of this problem are going forward and we anticipate that they will be completed in

approximately 60 days. We shall be glad to furnish the committee with the results of these studies.[1]

Very truly yours,

D. J. C. COPPS,
Vice President, Energy Division.

The comparative properties of HEF–3 fuel and Hi Cal–3 fuel, prepared, respectively, by Olin Mathieson and Callery Chemical Co., are shown on the chart, figures 1 through 5, which contains classified information and is transmitted under separate cover.

The ZIP Standard Test Specification Committee appointed by the Department of Defense established a program to exchange samples of the boron fuels among its various members. It was the intent of such a program to establish the properties of the materials that were anticipated to become production fuels. It was recognized that Olin Mathieson and Callery Chemical were preparing the high-energy fuels by two basically different methods. Olin Mathieson's process was designed to produce a high purity end product fuel. To accomplish this, and provide for maximum flexibility, intermediate materials were to be produced in high purity. These intermediates are diborane, pentaborane, and decaborane, now considered as essential to the ballistic missile and rocket programs. Callery's process was aimed at direct copolymerization of diborane to a final fuel. This avoided the production of any usable intermediates such as pentaborane and decaborane.

The ZIP Committee requested that Callery submit a quantity of their fuel designated as P–102–A (Hi Cal–3) and that Olin Mathieson submit a quantity of their fuel designated as S–87 (HEF–3). Table I, also transmitted under separate cover, contains classified information and shows the results of the analysis made on these two sets of samples by the various participating corporations and Government agencies.

It is noted from this table that the boron content of the HEF–3 is 118 percent of that of Hi Cal–3. Also, the carbon content of HEF–3, which produces lower heat value on combustion, is 66 percent of that in the Hi Cal–3.

Figure I of the classified portion of this statement shows the comparison of the Hi Cal–3 and the HEF–3, insofar as heat content, based upon determinations by the various participating corporations as members of the ZIP Committee.

This Committee performed thermal stability tests on the fuels produced by Callery and Olin Mathieson. The method of determination of thermal stability was to subject the fuels to high temperature over a period of time. Increase in pressure was used as a measure of the lack of thermal stability of the specific materials. It is noted that in figure 2 of the classified portion of this statement the pressure increase over a fixed period of time is much more rapid for Hi Cal–3 than HEF–3. These tests were run at the accepted temperature conditions of 350° and 400° F. Data shown in figure 2 was that obtained by NACA and reported on July 18, 1958.

Figures 3 and 4 of the classified portion of this statement show the thermal stability of the two samples at 350° and 400° F. as determined by Olin Mathieson. It is apparent that the sharp pressure increase exhibited by Hi Cal–3 over a shorter period of time is indicative of lower thermal stability at the set conditions.

At a meeting of the subcommittee of the High Energy Fuels Guidance Committee, established by the Air Force, on June 2, 3, and 4, 1959, Olin Mathieson and Callery Chemical reported on the properties of their respective fuels. The average viscosity data shown in figure 5 of the classified portion of this statement was obtained from the minutes of that meeting. The proposed maximum specification of 100 centistokes at —40° F. was intended to be established for the high-energy fuels.

As shown by the above analyses, in chemical composition, purity, and stability the Olin Mathieson fuel is far superior.

Mr. FULTON. Then will you comment on the construction of these plants, as to which ones were constructed by you on a cost-reimbursable basis, without fee?

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[1] When the information is submitted, it will be found in committee files.

Mr. COPPS. All the construction work that we have done on this entire program for the Government has been done without fee.

Mr. FULTON. And that includes the Lake Ontario Ordnance Works plant?

Mr. COPPS. That includes the so-called I.P.P. plant and the North plant, both of which are at location.

Mr. FULTON. And they total, both in all, $45 million?

Mr. COPPS. $45 million and 4½.

Mr. FULTON. 4½?

The CHAIRMAN. $50 million.

Mr. FULTON. Now, if you will look at your statement on page 6, stating that "this Air Force"—about halfway down the page:

> This Air Force production plant is a highly specialized one, designed specifically for high-energy fuels, and our entire effort has been devoted to process development for this purpose. In our opinion there is no commercial requirement for these fuels.

But that statement does not mean that there is not a very extensive field——

Mr. COPPS. Pardon me?

Mr. FULTON. For research and development in high-energy fuels for many purposes, in both the Department of Defense programs for military purposes, as well as under NASA for peacetime or rocket or missile purposes; does it?

Mr. COPPS. No. But we have understood that there is no quantity presently anticipated that would justify one of these plants.

Mr. FULTON. But if the research were done under NASA on the rocket and missile program, that would be getting us a high specific impulse type of fuel on our boosters, we might be able to use quite a bit of quantity, might we not?

Mr. COPPS. I would assume we should.

Mr. FULTON. Well, do you think that that is a worthwhile field to do some policy forming in?

Mr. COPPS. Yes, sir; we do.

Mr. FULTON. I am really adding onto this statement of yours the affirmative—the constructive—approach of what we might be doing where you have stated in the negative.

Mr. COPPS. I am referring strictly to commercial requirement.

Mr. FULTON. But there is a large field yet where this plant might be used for this high-energy fuel development and production, maybe, by modification?

Mr. COPPS. Part of it could, yes.

Mr. FULTON. And suppose that we did have requirements for various other types of fuels, of which boron is a basic constituent, there could be modifications made without too much expense, if we didn't tear these things down completely and lose the scientific teams and disperse everybody?

Mr. COPPS. That is correct.

Mr. FULTON. Is that correct?

Mr. COPPS. Yes, sir.

Mr. FULTON. So you see there might be an asset here that could be realized if there is proper policy determined and recommended by this committee, as distinguished from approaching this problem as either the uncovering or the rectifying of a mistake of a large amount?

Mr. COPPS. I think the Government, as well as ourselves, has a real asset in the team of scientists we have up there. And it is a real shame to me that team be broken up until we are definite that there is not going to be some continuation in this work.

Mr. FULTON. And that these facilities that have been constructed are enough of a general purpose nature that, with modifications of some amount, they could be used for other purposes in this high-energy fuel development?

Mr. COPPS. If there is a requirement established for the boron, yes.

Mr. FULTON. Well, you, yourself, are not satisfied with the particular type hydrocarbon fuels and liquid oxygen and hydrogen approach that we are using on our basic missile programs; are you?

Mr. COPPS. We believe that it is just a matter of time until they will have to come back and use this 40 percent advantage in B.t.u. content. But not being in anything except the fuel part, well, we have no basic information to make judgment on. But we feel strongly that there will be a requirement.

Mr. FULTON. Well, now, that is what I am coming to. When there is a lack of requirements because the development of the engines or basic components are not completed, it does not mean that we are then calling this particular program a complete loss, closing it and moving to something else.

Mr. COPPS. I don't consider this a failure in any way. I think this has been a real breakthrough in this boron chemistry, something that we all should be proud of, and I am sure—at least we hope to find some use for it in the near future.

Mr. FULTON. And where we are looking for a more stable fuel of a high specific impulse, it might not be particularly boron chemistry, but it could be something in this high-energy fuel for which these facilities and these scientific teams might be of real value if they are not destroyed?

Mr. COPPS. Yes, sir.

Mr. FULTON. Would you say that?

Mr. COPPS. Yes.

Mr. FULTON. And you think that there is a real basis for that policy, as distinguished from this mistake approach?

Mr. COPPS. Yes, I do.

Mr. FULTON. Do you have a technical person there?

Mr. COPPS. Yes, sir.

Mr. FULTON. With you?

Mr. SIEGELMAN. In what respect, sir?

Mr. FULTON. On this—on the basis for this adaptation of these facilities and scientific teams that are now in existence to other purposes within the high-energy field, although possibly not based on merely a boron foundation block. Are they usable? Are they an asset? Can they be used, without too much trouble?

Could you give your name and title right here at this place?

Mr. SIEGELMAN. My name is George Siegelman.

Mr. FULTON. What is your title?

Mr. SIEGELMAN. I am director of liquid fuels at Niagara Falls.

Mr. FULTON. All right. Then you would have the expert background to be able to make a judgment on that; wouldn't you?

Mr. COPPS. He is asking whether the teams should be kept together.

Mr. SIEGELMAN. Basically, my personal opinion is that there is much to be gained from maintaining the scientific teams to work on other areas of high-energy fuel if the boron proves to be a nonusable field. In our efforts at Niagara Falls, as an example, we have moved into other areas, looking for fuels of higher specific impulse—solids and other types of materials for missiles and rockets. All of our personnel can be utilized to contribute to this particular effort.

It appears we should be moving in this particular direction based upon the testimony that has been heard in past days.

Mr. FULTON. But you feel these teams are experienced enough and these facilities are of general purpose value enough that they could be used, say, on other elements of about the same characteristics and of similar or nearly similar atomic weight? You see, we are in a certain field of progress, either upward or downward. And the question is: Are we in an area where when one building block is not suitable for a particular purpose, but where it might be more productive to investigate the outer edges of this field?

Mr. SIEGELMAN. We personally feel, obviously, that there is much to be gained by, as I have stated, maintaining the scientific teams, and the facilities under modification and in some cases as they stand can be applied to new types of high-energy fuels.

Mr. FULTON. For instance, in the gasoline business, when there was a 100-octane fuel development program using lead, or various additives in that particular field, and if one did not prove satisfactory, they certainly did not disband the team; did they?

Mr. SIEGELMAN. That is right.

Mr. FULTON. They went on and moved them to something else and they didn't tear down their laboratory, their research building.

Now, then, the question comes for Government. Are we in that same situation here, where we have a broad field, and we have been emphasizing one building block for a particular purpose, the B–70 engine?

Now, a query: Is it possible in your judgment, because you are an experienced person and an expert in this field, to change and broaden this field so that we can use these facilities, or must we, as one member here has already said, call this a tragic mistake, a loss, and close them up?

Mr. SIEGELMAN. I hardly think in the broad concept that you can consider this a tragic mistake or error. Much has been gained in the breakthroughs in boron chemistry as well as in other fields of chemistry. Things that have been unknown up until 5 to 7 years ago have certainly come into the open as a result of the research that has been carried on.

Undoubtedly many of these areas are going to be expanded to utilize the potential that the materials have, whether they be for high energy fuel or for some other purpose. And the personnel that have been working on these items obviously can contribute rather handsomely to any program along this line.

Mr. FULTON. As a matter of fact, you have been working really with two elements in this program: Boron hydride and boron and nitrogen. Now, has there been any extension of nitrogen research, because that is certainly one leg of this foundation you are building, by combining with other elements?

Mr. SEIGELMAN. We are bordering—excuse me.

Mr. FULTON. Go ahead.

Mr. SIEGELMAN. We are bordering at the moment, when we talk in terms of going ahead with various elements of this type, on some contracts that we are presently engaged on, which are highly classified. I would prefer that we not go into the details of it.

Mr. FULTON. I better not go into the details of it. But there is a broad field, of which this boron is just part when we are speaking of high-energy fuels with high-specific impulses, that we should be looking into, under the research and development, either basic or applied, in the high-energy fuel program, under NASA, for example, as well as the military.

Mr. SEIGELMAN. That is right, sir.

Mr. FULTON. What would you both say on that?

Mr. COPPS. Yes; we should.

Mr. SIEGELMAN. Very definitely.

Mr. FULTON. So that you definitely feel that there is room for further programs if we can set these people to looking this field over further, to see what applications there might be? Would you both say that?

Mr. COPPS. Yes.

Mr. SIEGELMAN. Yes, sir.

Mr. FULTON. Thank you. That is all.

The CHAIRMAN. Mr. Hall?

Mr. HALL. Mr. Chairman.

I would like to thank you for coming here. I have in my congressional district in North Carolina a plant of Olin Mathieson of which we are very proud and which adds much to the economy of my district.

I have one or two questions.

You spoke a moment ago about a determination would be made to scrap either the materials in process or the plant within 60 days. To which did you refer?

Mr. COPPS. Our own company-owned plant.

Mr. HALL. Now, that company-owned plant, if NASA continues its research work, as it has indicated it will do in these fields, could that company-owned plant not be used in connection with what NASA plans to do?

Mr. COPPS. Yes; it could be.

Mr. HALL. Now, what would be the cost of putting on a standby basis rather than abandonment of this large plant, I think you referred to as the North plant?

Mr. COPPS. We have been unable to submit an estimate. We have been requested by the Air Force—and they are waiting on us now to give them some figures on standby, on different types of standby. We have not prepared those figures and I would rather—until we get them—not try to hazard a guess at it.

Mr. HALL. Will you submit that for the record, those figures?

Mr. COPPS. Yes.

Mr. HALL. When they are compiled. That is all.

(The information requested is as follows:)

It is impossible at this time, in the absence of definitive instructions from the Air Force with respect to procedures to be followed in the shutdown of the plant and placing it in standby condition, to arrive at a realistic estimate of the termi-

nation costs relating to operating contract AF33(600)-35077. However, we feel that such costs will run between $3 million and $4 million; sufficient funds to cover the above amount are available under the operating contract.

The CHAIRMAN. May I ask you one or two questions? Then we will complete the hearing.

I want to ask you this: Do you agree with the Air Force explanation as to why the program was canceled?

Mr. COPPS. Yes; they tell me there is no requirement. I have no way to question that.

The CHAIRMAN. And you think it is not due to the lack of quality of the fuel, but it is to the lack of need for the fuel?

Mr. COPPS. The quality has been met and the costs that predicted for them have been met. So I can't see how that could be any reason.

The CHAIRMAN. The Air Force stated, and the Navy also stated, that it was due to the changing conditions in which we enter a new era—the space era.

(Mr. Copps nods.)

The CHAIRMAN. And you think that is correct?

Mr. COPPS. I have no better way than to accept what they have told me.

The CHAIRMAN. I want to ask you one more question, then. I believe that will be all.

The housing there: Have you built any housing to take care of these employees?

Mr. COPPS. No, sir.

The CHAIRMAN. In your plant. No special housing built?

Mr. COPPS. No.

The CHAIRMAN. But that will leave 100 families—I mean 1,000 families affected in that area, by this operation?

Mr. COPPS. That is correct; yes.

The CHAIRMAN. I think that is about all.

We are about to have a vote over on the floor on the housing bill. So I think we have finished in a timely manner.

I want to thank you gentlemen from Olin Mathieson for coming here and helping the committee.

I want to say to the members of the committee we plan perhaps on having one more witness, and that witness will be from the Department of Defense. And the Defense Department could probably at that time tell us of any correlation between the two departments of Government, the Navy and the Air Force.

And what else went on in reference to this particular program leading to its cancellation.

Mr. FULTON. Mr. Chairman?

The CHAIRMAN. Yes.

Mr. FULTON. I would also like the level of decision at the time of these terminations. Where was it, by whom and whom approved.

The CHAIRMAN. That is correct.

The committee will stand adjourned until such time as announced by the Chair.

(Whereupon, at 3 p.m., the committee adjourned to reconvene at the call of the Chair.)

BORON HIGH ENERGY FUELS

TUESDAY, SEPTEMBER 1, 1959

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met, pursuant to notice, at 10 a.m., Hon. Overton Brooks (chairman of the committee) presiding.

The CHAIRMAN. The committee will come to order.

Members of the committee, this will probably be the final meeting of the full committee for this session of the Congress, that is, unless plans for adjournment change.

We have had a rather strenuous period. I think we have accomplished a great deal. We have certainly had a heavy work schedule, and we put out a number of very fine reports.

How many have we published, Doctor, from this committee?

Dr. SHELDON. I think you caught me unaware. If I were to make a rough estimate, probably 15 investigative reports and 6 legislative reports.

The CHAIRMAN. About 21 reports, and I think they are a credit to the committee. We ought to be proud of them. The doctor was just telling me now we have a backlog of requests for some of the reports that are an inch thick. We are now asking the Joint Committee on Printing to authorize additional copies of some of the reports, so heavy are the demands. So the committee is working for itself a place in the economic structure of this country.

This year we have had 20 open hearings of the subcommittees and 7 closed hearings of the subcommittees on legislative and investigatorial matters.

We have had 65 open and 25 closed hearings of the full committee, totaling 112 hearings in all that we had of the full committee. In these meetings we have accomplished the following: We have three public laws which have been put through; they are now in full force and in effect. Two bills are awaiting the signature of the President of the United States at this moment. Then there are six bills reported on the House Calendar. I think, as I say again, that is an excellent record.

In addition to these legislative accomplishments, we have had a number of special subcommittees making inquiry into important subjects, which also contributed greatly in assisting us in advising the Congress and public generally on space technology. These efforts may or may not lead to future legislation, but all of these special subcommittees have worked hard, and I personally want to thank every member of the subcommittee for the loyal cooperation that they have given this new standing committee of Congress.

46191—59——8

Now, this morning, members of the committee, we have one witness; that is, the Honorable John B. Macauley, Deputy Director of Defense Research and Engineering. The subject he is to cover is the high-energy fuels, which is a continuation of our previous hearings.

Mr. Macauley, you have a prepared statement this morning, and we will be happy to just proceed with your prepared statement.

Off the record.

(Discussion off the record.)

The CHAIRMAN. Back on the record.

STATEMENT OF JOHN B. MACAULEY, DEPUTY DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING; ACCOMPANIED BY DONALD B. BROOKS, CHIEF, FUELS AND LUBRICANTS DIVISION, OFFICE, DIRECTOR, DEFENSE RESEARCH AND ENGINEERING

Mr. MACAULEY. Mr. Chairman, I am very happy to be able to appear before you and members of this committee and to give you the statement of the part played by the Office of the Director of Research and Engineering in this program. I have with me Mr. Donald B. Brooks, Chief of our Fuels and Lubricants Division, who has had a long continued connection since 1956 with this program, and for that reason I have asked him to sit by me here.

Presentations last week by the Navy——

The CHAIRMAN. May I interrupt you a moment to say this: The members of the press—and I would think it would be all right this morning—we don't have too many members of the press. We do have some staff seats there. If you gentlemen would come forward, a couple can sit on each side there and you won't crowd out the members of the committee and still give you a chance to hear. I think the members of the committee understand it, and if they come in late we can make rearrangements for the late members.

If you speak up a little bit, if you want your words reproduced in the press, you better speak up, I will put it that way.

Mr. MACAULEY. Mr. Chairman, the presentations last week by the Navy, the Air Force, the National Aeronautics and Space Administration, Callery Chemical Co., and Olin Mathieson Chemical Corp. have detailed the parts played by these agencies in the high energy fuel program. This presentation will therefore be confined to the part played by the Office of the Director of Defense Research and Engineering and its predecessor organizations.

In November 1951, the Bureau of Aeronautics, Department of the Navy, made a top-secret presentation to the Research and Development Board outlining the potentialities of a fuel based on boron hydride. At that time there were no reasonable grounds for assurance that means other than aircraft would be able to reach targets in the homeland of the potential enemy. Such targets could not be reached by our aircraft without inflight refueling, a costly and difficult operation. Since the potential gains from the development of such a fuel would be highly rewarding, the Research and Development Board approved the Navy program for emergency funding.

At the request of the Navy the Research and Development Board formed a committee, known as the Joint Working Group on Special Fuels, to coordinate, guide, and integrate the research and develop-

ment efforts of the military departments in the field of high energy fuels for piloted aircraft. This working group comprised a representative from each of the three military departments, together with four civilian consultants. The number of consultants was later increased to eight. The membership of the present Joint Working Group on Special Fuels is shown in attachment A to this statement. The group held its first meeting on July 9 and 10, 1952, to be briefed on the project, the service programs, and its duties. At this meeting the group asked that the services undertake a study to determine what we could afford to pay for a fuel having the supposed advantages of the proposed fuels.

At that time, 1952, only the Navy had a program for the production of fuel based on boron hydrides. The Air Force, however, had been conducting a program on high energy fuels formed by suspending finely divided metals, such as boron and magnesium, as slurries in a hydrocarbon base. Thus, in effect, the Navy was using the chemical approach to high energy fuels, while the Air Force followed the physical approach. These programs consequently were complementary and provided excellent coverage of the field without duplication.

The Joint Working Group on Special Fuels met five times during the last half of 1952 and has met two or three times in each year since to review the programs and give guidance both to the services and to this Office. When it became apparent that engine evaluation of some of the fuels being developed would be warranted, thorough studies of the possibilities were made by the Technological Capabilities Panel (Killian committee) and a special group of project Lamp Light, known as the Lamp Wick Group. These studies were based on the recommendation by the Joint Working Group on Special Fuels that an independent review of this work be made. The final report of the Lamp Wick study (secret) was issued on March 15, 1955. On the basis of these studies by the Technological Capabilities Panel and the Lamp Wick Group, Assistant Secretary of Defense Quarles recommended to the Navy and the Air Force that steps be taken immediately to initiate a program for the design and construction of two 5-ton-per-day fuel plants, each based on a different process. He stated:

The primary purpose of these pilot plants will be to prove the process involved and to provide a sound foundation for the most effective and rapid expansion of production capacity.

As a result of this recommendation, work was initiated on the design and construction of two plants, one being handled by the Navy and one by the Air Force, which had found slurry fuels impractical.

In addition to the need for proving out the fuel processes selected for production of fuel, the decision to build two plants was motivated by the fuel requirements for developing an engine and afterburner capable of burning boron fuels. Such a development has been stated by one of our consultants, the director of engineering of an aircraft engine organization not involved in this program, to require a minimum of 1,000 hours of engine operation. The fuel consumption of the full-scale engine is approximately 5 tons per hour without afterburner and of the order of 20 tons per hour with the afterburner. Thus, 1 day's production of either plant would sustain the engine for 1 hour, or the engine plus afterburner for 15 minutes. With a minimum of

1,000 hours operation for engine development and approximately 150 hours for the afterburner development, it can be seen that the two plants were a minimum for the timely development of this hardware. In fact, only slightly over a year ago the Air Force was seriously contemplating the construction of a considerably larger plant to expedite engine development.

When fuel became available in small quantities, early engine tests cast considerable doubt on the ability to attain the improvement in performance which had been estimated from the fuel properties. First estimates of this improvement ranged upward from 50 percent. The most recent studies, as pointed out by the services, show that improvement is negligible at subsonic aircraft speeds and quite moderate even at supersonic speeds. In addition thereto, the fuel cost has not been reduced to anywhere near the value expected. In 1954 it was estimated that a fuel cost as low as 60 cents to $1 a pound would be possible at a moderate level of production. The estimates for the 5-ton-per-day plants which are under discussion are in the vicinity of $5 a pound after the plants have been brought fully on stream. This figure does not include general and administrative expenses which might be expected to increase it materially. With improved processes and larger scale production, the cast might be brought below $2 a pound.

These reasons, together with the rapid development of ballistic missiles, spurred as it was by the Russian success with Sputnik I, caused the services to reconsider their programs quite carefully. At a meeting of the Joint Working Group on Special Fuels on January 22, 1959, the Navy stated that their reconsideration had led them to reduce their estimated requirement to approximately one-fourth of the capacity of the Callery Chemical Co., Muskogee, Okla., plant.

The Callery Chemical Co. at that time outlined to the Joint Working Group the effect that the Navy cutback would have on their work, stating that 146 people had already been laid off, and that research had been cut back. They expressed the opinion that it was not feasible to run the Muskogee plant at part capacity. They had apprised the Air Force of their problems and had asked for help.

In view of the reduction in Navy fuel requirements, this Office requested the Air Force and the Navy to send representatives to a meeting for the purpose of considering single management of the two plants by one of the services. It was felt that if less than full capacity of the two plants was to be required, the most economical operation could be had only if both plants were under the management of one service. This meeting was held on April 23, 1959, but did not result in agreement by the Air Force, which had almost the entire fuel requirement, to accept single management.

When it became apparent that one of the two plants probably would be closed down, our Office on its own initiative negotiated a contract with Arthur D. Little, Inc., for an engineering study of the capabilities of the two 5-ton-per-day plants. The choice of Arthur D. Little, Inc., was based on the facts that promptness in completing the study and acting on it was essential if the Callery plant was to be continued, and that Arthur D. Little, Inc., had been engaged in earlier phases of the design of fuel production plants and in the Lamp Wick study, and thus already had much of the needed information.

Furthermore, at the urging of the Joint Working Group on Special Fuels, the Air Force had signed a contract with Arthur D. Little, Inc., for a thorough study of several new and advanced proposed fuel production processes to determine which had the greatest promise. This contract required that Arthur D. Little, Inc., stipulate that they would not engage in any work in this field for a subsequent period of 2 years. This stipulation was essential to assure the several organizations having fuel production processes that any information which they supplied to Arthur D. Little, Inc., representatives would not be used to a competitor's advantage. Obviously, for our comparatively small contract, $25,000, no other concern could afford to undertake such a stipulation. The results of this study are to be reported at the meeting of the Joint Working Group on Special Fuels on September 10, 1959, and as soon as possible thereafter recommendations will be made by this office regarding the future of the different plants.

Since it is not yet clear what the fuel requirements will be for the R. & D. program, we have subsequently asked Arthur D. Little, Inc., to give us as complete information as possible on the other three plants; namely, the 0.8-ton-per-day plant at Model City, N.Y., the Olin Mathieson Chemical Corp. company-owned plant at Niagara Falls, N.Y., and the plant owned by the Callery Chemical Co. at Lawrence, Kans. This office has also requested the Air Force and the Navy not to take any action which would impair the readiness of either of the 5-ton-per-day plant before October 1, 1959, to allow due consideration of the facts to be disclosed at our September 10 meeting.

In conclusion, we have endeavored to get the most competent engineering advice available to guide our recommendations throughout the course of this program, and especially regarding the operation of the fuel-production plants. This was particularly necessary when it appeared that only one of the 5-ton-per-day plants would be required since each of these plants will have an annual operating cost in the neighborhood of $20 million.

(Attachment A is as follows:)

JOINT WORKING GROUP ON SPECIAL FUELS MEMBERSHIP, AUGUST 31, 1959

Chairman: Dr. Robert C. Gunness, executive vice president, Standard Oil Co. (Indiana).
Dr. Daniel P. Barnard, consultant, Office of the Director of Defense Research and Engineering.
Prof. Herbert C. Brown, department of chemistry, Purdue University.
D. Gerdan, director of engineering, aircraft engine operations, Allison division, General Motors Corp.
Prof. Edwin R. Gilliland, department of chemical engineering, Massachusetts Institute of Technology.
Anthony J. Nerad, research laboratory, General Electric Co.
Addison M. Rothrock, Office of Program Planning and Evaluation.
Charles H. Winter, Jr., Elastomer chemicals department, E. I. du Pont de Nemours & Co., Inc.
John W. Crellin, Office, Chief of Ordnance, Department of the Army.
Commander R. H. Koch, Bureau of Aeronautics, Department of the Navy.
Allan Eaffy, Directorate of Research and Development, Headquarters, U.S. Air Force.
Marc P. Dunnam, Wright Air Development Center.

Mr. MACAULEY. This is without the administrative overhead which might double that figure.

This concludes the prepared statement, Mr. Chairman.

The CHAIRMAN. Thank you, sir. What is this on the back, the next sheet—the Joint Working Group on Special Fuels?

Mr. MACAULEY. This is the present membership of the Joint Working Group which is referred to at the bottom of page 1, which was formed by the Research and Development Board, the membership having been increased somewhat, and this is the present roster of that working group. This is the working group that will meet on the 10th of September to consider the R. & D. programs of the services and the report of the Arthur D. Little Co.

The CHAIRMAN. At that time they will come up with a final decision?

Mr. MACAULEY. I think they will come up with recommendations. They are an advisory group to the Director of Defense Research and Engineering, to our office, and I expect them to come up with recommendations as to what is their judgment of the best course to pursue, considering what the requirements now appear to be, and what the facilities are that are available to meet with these requirements.

The CHAIRMAN. Now, as I understand your statement, these plants were thought to be necessary in 1956, but when sputnik No. 1 was set off on its launching pad you made the decision—you changed your mind on it and felt that the emphasis was now on missiles; and my friend down there who is supporting you is shaking his head—but I will read him from the statement that has just been made here, which I underlined in reference to that.

This is on page 4:

> The most recent studies, as pointed out by the services, show that improvement is negligible at subsonic aircraft speeds and quite moderate even at supersonic speeds. In addition thereto, the fuel cost has not been reduced to anywhere near the value expected.

That is not exactly the quotation that I wanted there.

> These reasons, together with the rapid development of ballistic missiles, spurred as it was by the Russian success with Sputnik I, caused the services to reconsider their programs quite carefully.

Do you support that statement, which is a part of your record?

Mr. MACAULEY. Yes. I think I support it in this way: Sputnik I went up in October of 1957, so that——

The CHAIRMAN. Two years ago.

Mr. MACAULEY. Yes. We had been pushing our own ballistic missile program, and it showed substantial promise. The services then reviewed their own programs as to the tradeoffs between ballistic missiles and manned aircraft rather carefully at that time. This was what led to the Navy conclusion stated in January, that their reconsideration had led them to reduce their estimated requirement.

I think I would like to make one more statement to the committee, and that is the nature of the fuel that these plants produce. These plants were designed to produce a boron hydride type of fuel in a liquid form which was suitable for the fuel systems of existing aircraft. This is the reason for the processes that are now developed in these plants.

Our present view of the use of boron hydrides does indicate that boron hydrides would offer greater promise at the present time in propellants, in rocket propellants, either solid or liquid, and these rocket

propellants that we are thinking of, particularly the solid ones, do not require the so-called alkylated fuels which have the properties of pumpability and vapor pressure that are associated with the complete product of these plants.

The CHAIRMAN. Coming back, though, to my original question: The thing that changed your mind in reference to the need for this development was Sputnik I; that is correct, isn't it?

Mr. MACAULEY. Well, it certainly had a very great influence on our thinking, but it is not the only thing. But it certainly had a tremendous influence.

The CHAIRMAN. No. You say the cost there was not reduced anywhere to where it was expected. However, then you say further that it is estimated the fuel costs could be reduced to $2 per pound in the future. So actually, the cost was a minor consideration because you had not yet attempted to get it down to $2 per pound from $5 per pound. So in the final analysis, a major consideration was sputnik, wasn't it?

Mr. MACAULEY. Well, I think in the final analysis—yes, I think that is a fair statement, Mr. Chairman, that in the final analysis, it turned our thought from fuel for aircraft engines to fuel for rockets.

The CHAIRMAN. In other words, you finally realized, as a result of sputnik, that we had entered into the age of space, the space age, and your emphasis would be on space vehicles, rather than on manned aircraft; is that right?

Mr. MACAULEY. I think that is approximately right. That is a good statement, sir.

The CHAIRMAN. Thank you, sir. We will get that matter straight. Let me ask you this, then, as a follow-up: We have a very fine committee there, distinguished Americans, but why did it take 2 years for them to make up their minds in that respect?

Mr. MACAULEY. The amount of fuel that has been available for actual experimental work in engines had not and has not been very great. The fuel demand to really run a full-scale engine would be rather terrific, as I have indicated in the prepared statement.

Various things had happened meanwhile, which I think were brought out by Mr. Charyk in his statement to you, and that is, the aerodynamics of manned aircraft improved. The chances of using this kind of fuel in the rotating machinery of a turbojet engine did not look as good as they had at one time. The cost did not meet the estimated cost. It looked as though our $2 a pound—now is about as speculative as the 60 cents to $1-a-pound figure was then, so that the——

The CHAIRMAN. In other words, you do not think you could really meet the suggested $2 that you referred to on page 4 of your statement?

Mr. MACAULEY. We cannot have full confidence in the $2 figure unless we actually do fuel production process work. The point I would like to stress, Mr. Chairman, is that the uses for boron-type fuels, as we envisage them now in this research and development program, will probably be more in the field of missile propellants than it will be in the field of manned aircraft.

The CHAIRMAN. Let me ask you, if that is the case, we are making solid propellants anyway, aren't we, for missiles?

Mr. MACAULEY. Yes.

The CHAIRMAN. Have you given any thought to using these plants for that purpose?

Mr. MACAULEY. Yes, indeed.

This is one of the things that will be thoroughly discussed at the September 10 meeting.

The CHAIRMAN. Don't you think you are a little slow about getting around to that? It has been 2 years since sputnik went up, and we are developing solid propellants. We have operating plants. And yet you haven't come up with a decision as to whether or not this is suitable for that purpose.

Mr. MACAULEY. Work has been going on on boron for solid propellants, but we do need some experimental data to check our estimates as to what might be achieved with boron fuels in solid propellants. We need a good deal of work on how to formulate solid propellants if we use these boron-hydride compounds. In other words, I am saying that we need an R. & D. program on the use of boron fuels for missiles before we are on very firm ground as to exactly how much we need.

Mr. FULTON. Would the stenographer repeat that to me exactly, please? I want to take that down.

(Record read.)

The CHAIRMAN. Now, in other words, you yet have ahead of you a program to decide whether or not this boron fuel is suitable for a missile program?

Mr. MACAULEY. Yes; that is true. We compare it with various other fuels which are also available for missile programs, and we pick the next step which will give us a better missile fuel. This will require some further research and development work before we make that choice.

The CHAIRMAN. On September 10 you can't reach a final decision?

Mr. MACAULEY. No; that is correct.

The CHAIRMAN. So when do you think you will be able to reach a final decision as to the use of the plants?

Mr. MACAULEY. As to the use of the plants we have no need at the present time, for neither the Air Force nor the Navy have stated a requirement for the liquid type of alkylated boron-hydride fuel.

The CHAIRMAN. That is the type made in these plants?

Mr. MACAULEY. That is the type made in these plants.

The CHAIRMAN. So you have no program at all for the use of the plants as of this hour?

Mr. MACAULEY. There is a minimal program, perhaps, for use in ramjets which can readily be produced by the fractional-ton-a-day plant for the R. & D. program.

The CHAIRMAN. Now, Mr. Miller suggests this: Do you have any adaptation or change of the plants that will make it suitable for any program in the Defense Department as of this hour?

Mr. MACAULEY. That is one of the things that we hope to get out of the A. D. Little study, although that was not its original objective. The original objective was to determine which of these two plants, if it was necessary to shut down only one of them, which of these two plants would be most effective, and we were still looking at the liquid-type fuel.

In the course of the study, the various steps in the production of the fuel are considered and will be considered for possibly producing

the necessary fuel for the research and development program. However, the quantities forecast, as we see it now, without firm figures from the services who will present their programs on September 10—but as nearly as we can guess, these requirements for the next year or two can be fully met by the fractional-ton-a-day plants at Model City and at Lawrence.

The CHAIRMAN. One more question, then I am through.

Two years ago Sputnik I was sent up. Had you acted promptly in your decision, would this Muskogee plant have been built?

Mr. MACAULEY. The Muskogee plant, I believe, Don, was under contract at that time?

Mr. DONALD B. BROOKS. That is correct. It was contracted in 1956.

Mr. MACAULEY. It was contracted about 1956.

It would have been possible to stop that plant. However, at that time we were not as far along with our own big missile program and we were not as sure as we now are of our ability to perform with our own missiles.

The CHAIRMAN. If you made a prompt decision at that time, would that plant have been built up in New York?

Mr. MACAULEY. They were also under contract, I believe, at the same time.

The CHAIRMAN. But they had not been constructed?

Mr. MACAULEY. In 1957 construction was underway, sir.

The CHAIRMAN. It was underway as to the New York plant?

Mr. MACAULEY. At both plants.

The CHAIRMAN. Is that the case with all of them?

Mr. MACAULEY. Yes.

The CHAIRMAN. Some of the New York plants were finished by 1957; weren't they?

Mr. MACAULEY. There was a company-owned plant which I am sure was finished by 1957. The 0.8-ton-a-day plant in New York was nearing completion.

The CHAIRMAN. And the large plant up there, the $45 million plant was under construction, but just partially constructed?

Mr. MACAULEY. That is correct.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. You are an engineer, aren't you?

Mr. MACAULEY. Yes, sir.

Mr. FULTON. You are not the one that sets the overall policy on the decision whether to go into missiles or into planes as a strategic position of the United States of America, are you?

Mr. MACAULEY. No, sir.

Mr. FULTON. Nor are you qualified to make such decisions?

Mr. MACAULEY. No, sir.

Mr. FULTON. That is not part of the duties of your particular office, nor is it the duty of any of these particular groups that are looking into the engineering aspects of R. & D. programs in the Department of Defense?

Mr. MACAULEY. I think——

Mr. FULTON. Would you answer the question directly, "Yes" or "No," and then qualify?

Mr. MACAULEY. Well, I would say that my Office, the Office of the Director of Defense R. & D., is qualified to do these things because,

in order to have either missiles or aircraft, the Director of Defense Research and Engineering must advise the Secretary on what is to be developed. Then I would say "Yes."

Mr. FULTON. That is within the engineering field, that is not in the strategic field, however?

Mr. MACAULEY. No; that is correct.

Mr. FULTON. Then you come up with certain facts and capabilities that are used on a strategic and a policy level to determine which programs shall proceed. You are the engineering factfinders and recommenders, aren't you?

Mr. MACAULEY. We are the ones who initiate and approve the research and development programs; yes, sir.

Mr. FULTON. What is the distinction between your duties and those of ARPA?

Mr. MACAULEY. ARPA is an operating agency of the Secretary of Defense, and it works on those specific missions which the Secretary assigns to ARPA. Those missions include the military use of space as well as certain other missions. I don't have the whole list.

Mr. FULTON. But that, too, is in the research and development field, and that is not in the strategic balancing of programs where the overall policy of the U.S. Government is handled by the Department of Defense; is that not correct?

Mr. MACAULEY. I think that is correct.

Mr. FULTON. Then you had nothing really to do with making the decision how soon after sputnik to turn from planes to missiles, did you? So that when you are saying here that the decision was made, you are simply commenting on what somebody else did, not your Office?

Mr. MACAULEY. I think we are commenting on the decision of the Office of the Secretary, as advised. I believe the reorganization bill states that the Director of Defense Research and Engineering shall be the Secretary's principal technical and scientific adviser.

Mr. FULTON. On that level you are exactly right, but certainly you are not making these strategic decisions. If you think you are, you better check the statutes and the Secretary's Office, because I cannot let you sit here and let it appear the Secretary is not diligent in acting on strategic decisions as a result of Sputnik I. They are not yours, they are his own ideas, and not your actions.

Mr. MACAULEY. I think this is true, we are only one input to the Secretary's decisions.

Mr. FULTON. I hope that is right.

Mr. MACAULEY. The Joint Chiefs of Staff obviously have the duty of advising him on strategy.

Mr. FULTON. And the President, then, makes the final decision with the National Security Council; is that not right?

Mr. MACAULEY. That is correct.

Mr. FULTON. So that when those decisions are made as between missiles and planes, they are certainly not made at the level of your agency or your office in the research and development field for engineering, are they? I am trying to help you.

Mr. MACAULEY. No. You are correct.

Mr. FULTON. Then you have said, in other words:

I guess that I am saying, we need a research and development program on the use of boron fuels for missiles before we are on very firm ground as to what we need.

If I could paraphrase that, I would say that you mean that you need a specific program developed in the research and development field to cover the development of various boron derivatives to see what can be developed for missiles of every kind, both peace and war purposes. You are saying that, in the whole missile field, that we need a research and development program, aren't you?

Mr. MACAULEY. Yes.

Mr. FULTON. If you are saying we need that, you are saying that firmly, and it isn't in these words:

I guess I am saying we need a research and development program on the use of boron fuels for missiles—

because that isn't firm enough.

I think we really need it, and I think we better get going quickly the way the chairman has been speaking.

Mr. MACAULEY. I agree with Representative Fulton in thisr espect, and I would like permission to strike out the "I guess."

Mr. FULTON. It is more to clear your ideas up. Then in order to determine what we need in this very broad field, we should have a substantial program, shouldn't we?

Mr. MACAULEY. Yes, sir.

Mr. FULTON. Then under whose direction would that program get started in the Department of Defense; would it start with the authorization of the Secretary of Defense, Mr. McElroy, or at Dr. York's level, yourself, ARPA's level, or would it start down in, say, the particular agency, say, the Air Force or the Navy? Where do we get that initiated?

Mr. MACAULEY. We, in our Office, have a coordinating function to see that there is not unnecessary duplication.

Mr. FULTON. Yes; but where do we initiate such a program? I will talk about duplication later.

Mr. MACAULEY. Such a program could be initiated in either service or in ARPA. These are all operating agencies, and they all——

Mr. FULTON. Should we bring Roy Johnson in here from ARPA to see who initiates something? I want to get started on this. I don't want a big gap to appear with a couple of plants shut down. We are going to lose these scientific teams while we are monkeying around trying to guess whether we are going to make a decision. I want a decision made promptly on boron fuels in the missile field. I want the scientific teams kept intact. I don't want it to destroy communities, and I don't want it to destroy a company, the way the Callery Co. said, "We are out of business if the Government can't even make its mind up." I want action. Who do I get it from? Roy Johnson?

Mr. MACAULEY. I would think you would probably get the action out of—as to what the program will be—out of our September review, sir, from our Office.

Mr. FULTON. What happens to these plants in the meantime, and all these people that have their homes to keep up, their kids to go to school, the communities and their taxes, while you fellows are there making up your minds? You must remember on August 10 there was evidentally a decision at your level that there would be a closing of the plant in Oklahoma, and by August 12 there was a telegram out telling them to close down.

Now, you made a pretty quick decision there. Then when it comes to the plant up in New York, with 750 people, you can't make your

mind up. You were very quick on closing the one with 450 people, 5-ton capacity, at Muskogee, Okla., but now you do not close the one up in New York. Well, maybe the position should be taken, we need both scientific teams, and we don't want all this quarter of a billion dollars lost and to go down the drain by shutting the manhole cover on them. Maybe some of us don't want it in that context. The thing that has upset me this morning is the lack of decision and the lack of aggressiveness on pushing these scientific programs with firmness to see that this money isn't lost that has been spent and to keep these scientific teams alive, and keeping these communities going.

Mr. MACAULEY. May I speak to this, Mr. Chairman?

The CHAIRMAN. Sure.

Mr. FULTON. I wish you would.

Mr. MACAULEY. The scientific teams are something that we are very interested in preserving. The scientific teams are not largely the people who operate the two 5-ton-a-day plants. The two 5-ton-a-day plants produce, as I have said, a fuel for aircraft engines, a liquid fuel, and this was what the process was designed for.

We have asked both services to keep these plants on early availability until the 1st of October. The scientific teams we hope to preserve as much as possible when we get the research and development programs of both services and review them at the joint working group meeting on the 10th.

Mr. FULTON. Well, of course, what happens is, these scientific people see the plants closed down, no word from you, and no assurance, and so they begin looking around for another job, and it wastes away. That is the first thing.

The second thing is, when they talk about tearing down and dismantling the plants within 60 days, as was said here by each company, of course they begin looking around for another place to go. A man with a family isn't going to be caught right down to the very end with no other work.

Let us just finish with this. Having been on the aircraft scheduling unit in World War II, I am not inexperienced in this particular field. I was one of the representatives of the Navy, at Wright Field, where we were scheduling plane production during part of World War II for the British, the Air Force, the Navy, and whoever else wanted them. They had a group of us there doing that. Our problem then was on research and development, just as you are doing here—how to effectuate a good program.

Those of us who have been in the field know that you not only need the scientific teams, but you need the facilities; in order to operate the facilities you need chemists, physicists, mathematicians, you need everybody from that type of person to janitors. Once you destroy your facility, you have your research and development people, your scientists, up in the air with no place to land. The are "think" people. They might as well sit in this room and think. Unless you keep together both the facilities, the operating personnel, and the scientific team, you have destroyed that setup. So it is inadequate to me to say, Have the scientists wait around until some later decision is made with one plant closed back on August 12, and the other in a very uncertain state, so 750 people don't know what is going to happen.

Mr. MILLER. Will the gentleman yield?

Mr. FULTON. I will be glad to.

Mr. MILLER. If you let this scientific team disintegrate, how long would it take to reassemble it to get it up to any—any scientific research group—how long would it take to get it up to the level at which it is?

Mr. FULTON. I think the gentleman from California has a good point. And in as specialized a field as boron, boron hydrides, and boron derivatives, it couldn't be done, probably, because they will be immediately grabbed up by other people.

Mr. MILLER. To get a team comparable into the field, it would take longer perhaps than it would take to build the plant?

Mr. FULTON. It has taken at least 10 years of development in this particular field to come up to the level where we have been able to produce 5 tons a day capacities in two plants. It is a valuable asset of this country to have this in this high-energy fuel field. So that I am bothered about the fact that the time of decision is wasting away the scientific assets of this country.

Secondly, I am bothered about the fact that the basis of decision seems to have had the premise, and a necessary corollary, that one of these two plants must go, and one of the two scientific teams has to go.

Well, I used to be in the Navy in World War II, and I still remember the old Navy stories about making them walk out the yardarm—two walk out and one comes back. You try it sometime.

I think the policy is wrong, and I think that this committee has been very upset, if I can quote the chairman, over the expenditure that has appeared here and then the possibility arising that it will all go to the winds and be of no avail. I am sure that this committee, and I compliment Mr. Miller of California, is pretty one-minded clear across party lines, in seeing a good job is done in these missile fields and in these research and development programs.

I don't think that it is any part of your decision on the strategic balance and how much we do in the missile field, and I am very glad to hear you think it is Roy Johnson, of ARPA, because I am going to ask the chairman to bring up Mr. Roy Johnson, the head of the Advanced Research Projects Agency of the Department of Defense.

Mr. MACAULEY. He is one of the three that have an interest in these propellants. There are, however—the Air Force and the Navy—they also have programs in propellants for missiles, and I would like to point out it would cost us about $40 million a year, just operating costs, to operate both of these plants producing a fuel for which at the present time neither the Air Force nor the Navy say they have requirements for such a quantity.

Mr. FULTON. Yes, I am glad you are here, because nobody on this committee wants you to operate these plants to produce fuel for which there are no requirements, but we certainly want you to come up quickly with some sort of a plan that, if these plants can be used in the research and development of the boron hydride field as the foundation base for high-energy fuels for missiles, you get promptly on the job.

I can't emphasize that enough. That is an entirely different problem from this thing of simply operating a plant and producing fuels that you are going to take out and color with purple dye, like they did the potato program. That is not in the minds of any one of us,

but it certainly is in my mind that on your testimony—you better go back and look at it, and I ask you to revise it—that you have no part in the strategic decisions, and that you are an engineer.

And, secondly, that your research and development capacity is to make recommendations on engineering facts and developments to people who do make the decisions. I wish you would comment on anything that makes the Department of Defense look like that it has not promptly, after the sputnik, made up its mind in the missile field——

The CHAIRMAN. What concerns me is this: Had a prompt decision been made after Sputnik I went up, I think you would have saved the better part of $200 million on this deal.

Now, further, vacillation in reference to the use of the plants is going to cost you, as you say, $40 million per year, and I do not think the taxpayers ought to be saddled with that, because of the failure on the part of our executives to make prompt decisions.

Mr. FULTON. Will the gentleman yield?

I don't think you should come up here and make those inferences—that is what I am getting at; that you are not in a position to do it. It is not part of your job. I think you should stick to research and development and engineering.

Mr. MACAULEY. I think we are sticking to research and development when we say that we have not got the requirement for these quantities of the liquid fuel, that we believe there is a research and development program required for boron hydride fuels as propellants, and that it is our proposal to formulate immediately following the 10th of September such a research and development program.

Mr. FULTON. That is all, Mr. Chairman.

Mr. MACAULEY. But we will not have good facts available until that time, I think, on which to postulate such a program.

The CHAIRMAN. Mr. Miller.

Mr. MILLER. Who made the decision to discontinue these plants?

Mr. MACAULEY. The Navy and the Air Force.

Mr. MILLER. Who in the Navy and who in the Air Force?

Mr. MACAULEY. The——

Mr. MILLER. What level was it made at? Was it made there or was it made in the Office of the Secretary of Defense?

Mr. MACAULEY. No. It was made there in each service. The Navy made their decision and sent out their close-down orders. The Air Force made their decision and sent out their close-down orders. We concurred in those.

Mr. MILLER. Were those concurred in by the Secretary?

Mr. MACAULEY. They were concurred in by our office.

Mr. MILLER. Until they were concurred in by your office, they couldn't be final or effective, is that so?

Mr. MACAULEY. We actually did ask the two services to withold any action that would render these two plants unavailable until after we had had time to do the September 10 review.

Mr. MILLER. Well, then, the responsibility for closing these plants is yours?

Mr. MACAULEY. I think we share in the responsibility. The responsibility for closing them was the responsibility of the service that contracted for the plants.

Mr. MILLER. Aren't they merely the ones who implement the thing? I have always been under the impression that in the military services we could pinpoint where decisions are made.

Mr. MACAULEY. Well, the decision in the services was made, I believe, in both cases, at the level of the Assistant Secretary, R. & D., for both the Navy and the Air Force.

Mr. MILLER. The Navy or the Air Force could not close these plants on their own responsibility, could they?

Mr. MACAULEY. Yes, sir, unless we intervened.

Mr. MILLER. Didn't they have to go to you, go to the Assistant Secretary of Defense for final approval?

Mr. MACAULEY. We have not yet, sir, given final approval to either plant for shutting down or completely disposing of these plants.

Mr. MILLER. I am not talking about the disposing of them now. I am talking about discontinuing the program.

Mr. MACAULEY. Yes, we concurred in their discontinuance of the program of the fuel for the jet engines.

Mr. MILLER. So then the responsibility fixes itself with the Assistant Secretary of Defense for Research and Development? That is where the law places it, isn't it?

Mr. MACAULEY. Yes.

Mr. MILLER. Am I correct in that assumption?

Mr. MACAULEY. Yes, if we had intervened. We did concur, as a matter of fact, Mr. Miller.

Mr. MILLER. In other words, you concurred. So if we wanted to find out where the responsibility for this is, it is in you?

Mr. MACAULEY. Yes, sir.

Mr. MILLER. I have no further questions.

Mr. SISK. Mr. Macauley, I believe that is correct; I do not want to be critical of you here this morning, but never in my life have I had more adequately and more clearly brought to my attention the total lack of organization and the absolute imperative need for the reorganization of our Defense Department than I think some of the colloquy here this morning pointed out.

I for one have been one of those who have advocated that I did not want to see all of our military people put in one uniform, but I think we, in this country, and our taxpayers, have been faced with this situation long enough. I think the time has come when we are going to have to clean out the whole situation over in the Pentagon and start anew and put them all in one uniform and see if we can't find out who is responsible for what.

We have had Mr. Roy Johnson down here, and I have a great deal of regard for Mr. Johnson; and yet, when it comes to pinning down specifically the responsibility for given programs, and who finally has the right to say "Yes" or "No"—it seems to be impossible to determine.

Let me ask you, Mr. Macauley, How many research and development programs are going on under the Department of Defense today in fuels for ballistic missiles, fuels for aircraft, exotic fuels—how many programs; do you know? And if you do not know, who in the Department of Defense does know how many programs are in existence today, specific programs, contracts, and how many companies are involved?

Isn't it a fact there are dozens and dozens and dozens of them?

Mr. MACAULEY. There are a number of specific contracts. There is a program, as we call it, in ARPA, on advanced solid propellants. There is a program in the Air Force and in the Navy on advanced propellants for missiles.

There are a number of tests and contracts under these programs. Some of them are quite small, some of them are reasonably large. None of them are anywhere near the size of this effort to get enough liquid fuel to test an engine. The size of this program, sir, comes from the fact, as I brought out, that you could run an engine at full power for about an hour on the day's output of one of these 5-ton-a-day plants, and with the afterburner operating you could run it for about 15 minutes on the output of one of these plants. This is what is the size of this particular program—the need for enough fuel to evaluate the engine, to see whether or not it was really a worthwhile venture.

Mr. SISK. Let's get down, Mr. Macauley, to specifics here. The gentleman from Pennsylvania, as I understood it, drew from you a definite statement that you felt that we were in need of another R. & D. program in the use of boron fuels for our ballistic missiles and rockets.

Now, the question that I asked you was, How many programs do we have going at the present time dealing with these very specifics—these fuels for rockets and the vehicles that will propel ICBM's and space satellites, and so on? How many programs and who in the Department of Defense has the overall final say as to how many more we are going to add to those already in existence?

Do you have that authority, Mr. Macauley, as the Director of Research and Engineering in this field?

Mr. MACAULEY. I am the Deputy Director. The Director of Defense Research and Engineering has the authority to approve a program or to terminate a program.

Mr. SISK. That is the position you hold. You are the Director of Research and Engineering.

Mr. MACAULEY. No; I am the Deputy; Dr. York is the Director.

Mr. SISK. You are a Deputy under Dr. York?

Mr. MACAULEY. That is right. The programs, as we call them, are the programs which ARPA is conducting in basic research on propellants.

The program which the Air Force is conducting in basic research on propellants and programs which the Navy and also the Army are conducting in basic research on propellants—all three services have their specifically defined interests and all are interested in our funding planning work of this sort as their program. I could not give you the number of propellant contracts without referring to the record.

Mr. SISK. Isn't it just the reasonable, good, ordinary horsesense that somewhere there should be one person or one agency that would have the final responsibility as to how many of these programs and how broad in scope they are to be, in order to justify what we are doing?

I think this is the most tremendous violation of our taxpayers' concern and interest; it is all over the field in this program. I do not understand why the Army, the Air Force, and the Navy should have any particular rights to go out on their own and set up these programs, except as they are dircted by some single agency that is empowered to do that job. That is the point I am trying to get at,

Mr. Macauley. Maybe I am not doing a good job in asking the questions.

Mr. MACAULEY. Perhaps I can throw some light on that. Our office does monitor these programs through our advisory committees, and in this boron field through this special joint working group, and we do review the programs to see that there is not unwarranted duplication, that the fields being covered by ARPA do not unnecessarily duplicate the fields being covered by the Air Force or the Navy or the Army.

It happens that the Army is presently, I believe, not particularly engaged in the boron hydride type of solid propellants, that the Air Force is actively engaged in this field, and ARPA is looking at this field with considerable interest.

I do not know, Don, whether they have any actual contracts on boron solid propellants or not. I do not believe they do.

Mr. SISK. It is a fact the Army is right now in the process of letting what will be a big contract in the solid propellant fuel field; is it not?

Mr. MACAULEY. Yes, sir; but the propellants that we are talking about, the contract that they are talking about is for the procurement of large grains of propellants which are quite well known.

What we are talking about in developing this R. & D. program, is developing more efficient propellants than those which are now known or available to us.

The CHAIRMAN. Will the gentleman yield?

Mr. SISK. Yes.

The CHAIRMAN. But the Army has your solid propellant program now, it has the arsenal and all that; doesn't it?

Here you set up two different organizations to do it. Isn't what you really need, as Mr. Sisk says, a section or a division or a department of solid propellants for missiles, with all authority under one department?

Mr. MACAULEY. I think that would perhaps not operate as well as you might think, because each service does have some rather specific requirements which they crank in on their own particular missiles.

For example, the Air Force and the Navy are both interested in very large missile grains.

The Army is interested in large grains but their interest is less. The Army propellants are required to be at least reasonably insensitive to temperature.

The Navy, in many of their applications, has a very narrow temperature range in which they have to have their propellants operate, because the temperature of the sea water does not vary very greatly.

The Air Force has a variety of requirements, depending on whether this is for an airborne missile or whether it is for a missile which is to be fired from a shore installation where the temperature of the propellant can be controlled.

These are simply some of the factors that make different approaches desirable in our point of view.

Mr. SISK. Mr. Macauley, let us get back for a moment to this specific program here. We could go on indefinitely, because as I say, I am becoming more and more of the opinion there is no department of

the Government that needs reorganization more than our Department of Defense.

What was the total amount of money earmarked or put into this specific program here for boron fuels in fiscal 1958? Do you have that figure there, the total amount put into the fuel program?

Mr. MACAULEY. We do not have the specific figure here, but the part of the fuel research funds is $10 to $15 million.

Mr. SISK. Fiscal 1958?

Mr. MACAULEY. Yes.

Mr. SISK. What was that—was that the year in which money was set aside for the construction of two plants, referring to the construction funds?

Mr. MACAULEY. The plant construction was funded in fiscal year 1957.

Mr. SISK. What was the total amount of the construction cost?

Mr. MACAULEY. It was $81 million for the construction of the two plants.

The CHAIRMAN. Then you had extra for another plant, something like $8 million as I remember.

Mr. SISK. How much money was funded in fiscal 1959 for this specific project? What is your 1959 funds?

Mr. MACAULEY. I do not have the fiscal 1959 funding.

Mr. SISK. Can you give me any round figures?

Mr. MACAULEY. I think the Navy in fiscal year 1959 did cut their program. The Air Force program went on at about the level of fiscal year 1958.

Mr. SISK. What was requested in fiscal 1960 to budget this program?

Mr. MACAULEY. The F–60 budget figures have not yet been reviewed nor has apportionment of it been recommended.

Mr. SISK. There was a request made by DOD, though, for so much money. How much money did you request for 1960?

Mr. MACAULEY. The budget request, do you have that in there?

Mr. DONALD B. BROOKS. No; I do not.

Mr. SISK. I ask as an unanimous consent, Mr. Chairman, that Mr. Macauley or whoever is responsible, to furnish for the record the total amount of money both construction and operation funds, fiscal 1958 and 1959, and the amount requested for this program in fiscal 1960.

The CHAIRMAN. Can you do that, Mr. Macauley?

Mr. MACAULEY. Yes, sir; we can do that.

The CHAIRMAN. And by fiscal years?

Mr. MACAULEY. By fiscal years; yes, sir. This is the budget request that you desire?

The CHAIRMAN. You want the funded amount?

Mr. SISK. I actually want the amount funded, Mr. Macauley, for 1958 and 1959. Of course, on 1960, I realize no funding has been made.

I merely was interested in what your requests were for 1960.

This all has to do with money, frankly, that in my opinion went into this program after it seems to me some grave questions should have been asked about it, because by your own testimony, there is some question about the advisability of continuing this program which should have affected all three of these budget years.

I am just a little bit curious. I want to ask you about this Lamp Wick Group.

In the early part of your statement you indicate the various groups doing study work and so on, on this, that one of the groups was the so-called Lamp Wick study which you indicate was secret at that time. Is that report still secret? Is that still classified information?

Mr. MACAULEY. This is still classified as secret, sir.

It has not yet been declassified.

Mr. SISK. That report was issued on the 15th of March 1955; is that right?

Mr. MACAULEY. Yes.

Mr. SISK. Do you know of any reason why that still continues to be classified?

The CHAIRMAN. Did you not say it had been declassified?

Mr. MACAULEY. It has not, sir; no. It would have to be declassified by the issuing agency, which, in this case was the Massachusetts Institute of Technology, operating under a joint Navy-Air Force contract.

The CHAIRMAN. Can you let the committee have that report in executive session, or just the information for executive use?

Mr. MACAULEY. I think we can, sir.

(Funding request and Lamp Wick report were submitted for the record. Both items are classified.)

Mr. SISK. Just the one other question, Mr. Chairman.

When was the B–70 program initiated? When did the B–70 system actually come into being? When were the original contracts let on that, do you know?

Mr. MACAULEY. The initial B–70 contract I think was the end of 1957, as I recall it—or fiscal 1958.

Mr. SISK. And was it at that time that there were requests made for work in these high energy fuels, the boron fuels? Is that when the first interest occurred? It is my understanding from your statement that certainly in connection with this program it was felt that there would be a need for fuels of this kind and of course now as I understand that has been of course completely changed—that is, there is no longer felt to be any need for it in the B–70 program.

Mr. MACAULEY. Yes. The B–70 program, as initially presented to the Office of the Assistant Secretary for R. & D. did include work on boron fuels as part but not the major essential part of the system.

Mr. SISK. Mr. Macauley, I appreciate your testimony here this morning. I have not made, as I said, any personal criticism. I do feel strongly if we had a consolidated and coordinated operation in the Department of Defense, where the left hand knew what the right hand was doing, a lot of this money could have been saved, as well as hundreds of millions in other programs.

I just hoped sometime in the very near future we are able to do something that will eliminate what I feel to be just a gross waste in these programs.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Chenoweth.

Mr. CHENOWETH. How many plants were built in this boron-fuel program altogether?

Mr. MACAULEY. There were five plants all told.

Mr. CHENOWETH. Two in Oklahoma?

Mr. MACAULEY. No; Callery has two plants; one in Lawrence, Kans., and one in Muskogee. The Olin Mathieson Co. has three plants; one of which is a company-owned plant in the vicinity of Niagara Falls.

Mr. CHENOWETH. You mentioned one at Model City, N.Y., one at Niagara Falls, N.Y., and one in Kansas, there are two in addition to that. Where are the other two?

Mr. MACAULEY. The other two are the Muskogee, Okla. plant which is one of these 5-ton-a-day plants, and the Model City plant, which is the other 5-ton-a-day plant. These other three are the smaller plants.

Mr. CHENOWETH. The second is the largest one; Muskogee and which other one?

Mr. MACAULEY. Model City, N.Y.

Mr. CHENOWETH. What is the status of those two plants right now?

Mr. MACAULEY. The status of the Muskogee plant is that it is being held in standby. The working force is being reduced. The status of the 5-ton-a-day plant at Model City is that the working force there is also being reduced to accomplish a standby position.

Mr. CHENOWETH. Both of the plants are on a standby basis?

Mr. MACULEY. The action of the Navy on the Muskogee plant preceded that of the Air Force on the Model City plant by a week.

Mr. CHENOWTH. These three smaller plants, where do they fit into the program?

Mr. MACULEY. The Lawrence plant and the small plant at Niagara Falls are company-owned. The 0.8-ton-a-day plant which is also at Model City, or practically there, is an Government-financed plant.

Mr. CHENOWTH. You have two plants at Model City.

Mr. MACAULEY. That is correct.

Mr. CHENOWTH. The one larger and the other smaller?

Mr. MACAULEY. That is correct.

Mr. CHENOWETH. What, in your opinion, will be the future of these plants? Would it also appear you have no need for this fuel that you thought at one time you might require?

Mr. MACAULEY. At present and in the immediately foreseeable future, we do not have any requirement by either the Navy or the Air Force for the complete product of these plants, the 5-ton-a-day plants for use in manned aircraft. The R. & D. program, which we propose to formulate on the 10th of September, will unquestionably use some, though not necessarily all of the facilities and personnel of the smaller plants.

Mr. CHENOWETH. As I understand the background of the criticism in this situation, you did not cut down soon enough after you ascertained you were not going to need the fuel. What is your explanation for that delay?

Mr. MACAULEY. The Navy, in January of this year, indicated to the Callery Chemical Co. that they were going to have a problem because their requirements were reduced.

The Air Force scratching of the requirement for the fuel came immediately on the heels of their decision that they would not develop the J–93–5 engine.

Mr. CHENOWETH. When was that? what month?

Mr. MACAULEY. That was in August of this year.

Mr. CHENOWETH. Just in August?

Mr. MACAULEY. Yes, sir.

Mr. CHENOWETH. After the decision of the Navy in January, what steps were taken to reduce the output of the program?

The CHAIRMAN. The Navy did its best to interest the Air Force in taking it. That is really what happened.

Mr. MACAULEY. The Navy indicated they could not use the full product. They would need at most then only about one-quarter of the product of the Muskogee plant. They attempted to interest the Air Force, as did we, in fact, and it was at that stage that we decided to initiate the A. D. Little study to see whether if only one of these plants would be operated, what was the most economical thing for the Government to do, to operate both plants at reduced capacity, or one plant at full capacity, and this was the purpose in initiating our A. D. Little study.

Mr. CHENOWETH. What is the status of that right now?

Mr. MACAULEY. That report is due to be presented to the committee, to the Joint Working Group on Special Fuels on the 10th of September.

Mr. CHENOWETH. Do you feel all this criticism that has been leveled at the Defense Department is justified? The charge has been made that the right hand did not know what the left was doing, that there was prolonged delay, and unnecessary funds expended for no good purpose.

What is your explanation and defense of those charges?

Mr. MACAULEY. I think the explanation in defense is that you change your minds rather slowly as to the relative promise of a program such as this and the facts that changed the Air Force's opinion—the Navy's opinion was formed rather earlier when they changed their ideas as to several factors of the use of this kind of fuel on a carrier force—the Air Force was changed as they got some actual data on the running of engines on this fuel and some actual aerodynamic data on what the power requirements would be for the B–70.

Mr. CHENOWETH. As you look back over this period, do you see now where, perhaps, you were a little tardy in making certain decisions that resulted in some money being spent unnecessarily?

Mr. MACAULEY. I could have very good hindsight, Mr. Chenoweth, but I do not think that at the time we saw there was a real problem here, that was at the time when the Air Force was very "hot" for the B–70, and the Navy had decided that they were unwilling to face up to some of the problems involved with the fuel for Navy aircraft in carrier operations.

There is a problem in the logistics of such fuels for carrier task forces, and the Navy recognized this a little earlier than did the Air Force who were figuring on a land-based, continental U.S. system.

Mr. CHENOWETH. These were military decisions at a high level, involving a decision of this importance?

Mr. MACAULEY. Yes, it was.

Mr. CHENOWETH. It appears the money spent on this is charged off to research and development. We will not have any practical benefit from it. Is that it?

Mr. MACAULEY. We hope we will have out of our R. & D. program a fair amount of practical benefit.

Initially, nobody had made more than test-tube quantities of some of these boron compounds.

We have learned a good deal about them. We are planning for and we hope our research and development program will still find good uses for boron compounds, though not these particular boron compounds.

Mr. CHENOWETH. What is Mr. Little doing with his studies? What will his report contain? What will be the advantages in having the report?

Mr. MACAULEY. The A. D. Little Co. was initially requested to report on the process, and relative promise of the two plants for making the liquid fuel.

At our request, the A. D. Little Co. is also looking at what is the adaptability of the two processes to fit the needs of possible developments which we might make in the R. & D. phase.

Mr. CHENOWETH. Does A. D. Little Co. have any control over these two plants?

Mr. MACAULEY. No; they are purely consultants——

Mr. CHENOWETH. I see.

Mr. MACAULEY. To us. The A. D. Little Co. is evaluating these two processes in these two plants at our request.

The CHAIRMAN. Are there further questions?

Mr. CHENOWETH. Just the one further question: How many men at Muskogee now? And how many men at Model City?

Mr. MACAULEY. The last figures I have—the Muskogee force had been reduced from 450 to approximately 200 people.

The force at Model City had been reduced by about 200 people from a level of about 750.

Mr. CHENOWETH. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Karth.

Let me say this: I have no reference to anyone. We have a conference report we hope we can get up at noon today, so I mention that to you. Some of our members have been here sitting patiently during all of these hearings, and we hope we get a chance to get around to everyone.

Now, Mr. Karth.

Mr. KARTH. Mr. Macauley, I would like to associate myself with the remarks that the gentleman from California made—and especially as they relate to a great need for apparent reorganization in the Department of Defense, probably starting right at the top and going all the way down to the bottom.

It seems that every time there is a new program being developed—whether R. & D. or otherwise—each branch of the service plus half a dozen Government agencies are claiming jurisdiction.

If something goes wrong, however, everyone wants to disclaim any jurisdiction, and, quite frankly, it appears today that this jurisdiction is evidently given even to someone who does not deserve it, like yourself, perhaps.

Perhaps a good deal of our $40 billion military budget is not being spent in the best interest, because of the reorganization need, or the need for reorganization.

Let me ask you this question: What is the status insofar as the decision is concerned of making the B–70 operational; do you know?

Mr. MACAULEY. I have no word on the status of making the B–70 operational.

The CHAIRMAN. As I understand, the program is going ahead on the B–70. The only difference is they do not plan on using the boron fuel for the afterburner.

Mr. KARTH. This point I am not sure of, Mr. Chairman.

Mr. MACAULEY. That is the present status, as the chairman stated. The B–70 program is presently, I think, three aircraft and associated systems.

No decision to make it operational has been taken so far as I know, but the program itself is going ahead, except for the J–93–5, which is the engine for the boron fuel.

Mr. KARTH. Because of the cost plus other disadvantages of the boron fuel as it relates to the advantages it would have in extra speed, and so on?

Mr. MACAULEY. Yes.

Mr. KARTH. The disadvantages probably outweigh the advantages, isn't that correct?

Mr. MACAULEY. I think so. It is not so much the extra speed as much as the extra range.

There are a number of things that contribute to this. In the first place we have not gotten as much of the heat value out of the boron fuel as we had hoped to get.

In the second place, the aerodynamic advances on the B–70 make it look as though the advantage of the boron fuel would be of the order of 10 or 15 percent in range. It would not obviate the necessity for refueling, in all probability.

Mr. KARTH. As far as air-breathing engines using boron fuels are concerned, the requirements are fairly negligible at this time.

Mr. MACAULEY. Yes, sir.

Mr. KARTH. Further than that, I understood you to say you are desirous of finding use for this boron fuel in missiles.

Let me ask you this question: If boron is given an added margin of performance beyond the hydrocarbon, how do these advantages compare with hydrogen-oxygen or hydrogen-fluorine, used in liquid fuels? How do the advantages compare with these liquid fuels?

Mr. MACAULEY. The hydrogen-oxygen is a very efficient propellant. It possesses some very difficult problems. They have to be maintained at low temperature. The hydrogen is a very light fuel—that is, its density of liquid hydrogen is low, so you multiply the size of the fuel tank by a factor of about nine for the same number of pounds of liquid hydrogen.

So that you have certain tradeoffs in these fuels, and if you are looking for certain qualities in your system, hydrogen looks like a very good fuel for space exploration because you are not there faced with the necessity for hardening, and you can shoot when you want to shoot rather than having your firing time dictated by a military necessity.

Mr. KARTH. How do the boron fuels then compare with aluminum and beryllium and some of the other more stable fuels?

Mr. MACAULEY. They look promising at the present time. Not these particular boron fuels, but certain propellants that might be made with pentaborane or decaborane look promising, and this is why

we feel a research and development program in those fields is an important thing for us to do.

Mr. KARTH. What is the difference between high-cal and high-energy fuels? Is there a significant difference?

Mr. MACAULEY. There are two different company names. Olin Mathieson calls theirs HEF–1, HEF–2, HEF–3, and Callery calls theirs HiCal 1, 2, and 3.

Mr. KARTH. Are they the same in property primarily?

Mr. MACAULEY. Not entirely, because the process affects them slightly, but in general they are very similar fuels.

Mr. KARTH. The reason I asked the question, I think previous witnesses in connection with the Air Force testified the reason they built the two plants is because the two plants manufacture different fuels; there are different needs for it. I was trying to find out whether or not this is correct, whether or not the fuels are so divergent in properties to necessitate the expenditure of $40 million in one plant.

Your testimony is the fuels are relatively the same; is that correct?

Mr. MACAULEY. They are quite similar fuels.

Mr. KARTH. They were both designed for the 5 engine; weren't they?

Mr. MACAULEY. No, sir. The Callery plant was supported by the Navy for Navy aircraft.

Mr. KARTH. I see.

Mr. MACAULEY. The Olin Mathieson 5-ton-a-day plant was designed to supply fuel to meet the Air Force specifications for the J93–5 engine.

Mr. KARTH. There is no essential difference, however, in the performance of these two; is that correct? That is, there is no essential difference in the performance of the two fuels, one that is manufactured in one 5-ton-a-day plant, and the one that is manufactured in the other 5-ton-a-day plant.

Mr. MACAULEY. There is presently some difference in performance coming out of the two processes.

Neither of them has lived up to the heat content expected of them, and there are differences which the Air Force put stress on, of thermal stability of some of the products, but probably both processes could turn out a fuel that would be reasonably suitable for either use.

Mr. KARTH. Mr. Chairman, that is all.

The CHAIRMAN. Mr. Wolf?

Mr. WOLF. Thank you, Mr. Chairman.

May I ask, has anyone asked the qualifications of this A. D. Little Co. to carry on their work? Has that been put in the record?

The CHAIRMAN. No, that has not been put in the record.

Mr. MACAULEY. I think that they have been stated on page 5 of the text.

Mr. WOLF. I read this page 5, too, and that is why I asked the question.

Mr. MACAULEY. They are one of the leading chemical engineering consulting firms in the country. They have been associated with—some of their people have been associated with this program. You will see that there are people from A. D. Little who were on the "Lamp Wick Study Committee." They are extremely capable in process studies, and they are not contractors to produce material. They are not in the business, in other words, of getting contracts to make fuels.

Mr. WOLF. Mr. Chairman, we ask unanimous consent to have a thorough breakdown of their background and what they have done before that that would qualify them to do this work be put in the record.

The CHAIRMAN. Would you place that in the record?

Mr. MACAULEY. Yes.

NOTE.—The A. D. Little Co. qualifications were received by the committee. The Department of Defense classified the insert and the qualifications are held in the committee files.

Mr. WOLF. I am not clear specifically on what Little has recommended. I have read something here, but it does not seem clear to me. Maybe it is because I cannot read well. The discussion later has not brought it out exactly.

Are they suggesting they are going to keep one of the plants open, or two plants open?

Mr. MACAULEY. That report has not yet been made.

Mr. WOLF. There is nothing official on that at this point.

Mr. MACAULEY. There is no report. This is the report which we expect to receive from the A. D. Little Co. on the 10th of the month—10th of September.

Mr. WOLF. There is another question that occurred to me. In your discussion you said there are still uses for these fuels, but not for these particular boron compounds.

I am not clear. Can these plants produce other fuels; is that correct?

Mr. MACAULEY. They can be modified to produce certain intermediates to produce other fuels. Both plants produce diborane. The Callery process, as at present, does not produce pentaborane, which is one of the compounds which look promising. Both companies, I believe, have a potentiality for making some decaborane.

Callery can be properly converted.

The point I would like to make, if I may, is that the materials which we would presumably look for would probably be some of these intermediate boron hydrides combined with other compounds to make a propellant—either a liquid or a solid propellant.

This is the objective of the research and development program: to find out what such compounds can be, and how good they are, and what our need for them might be—to evaluate them.

Mr. WOLF. Might I also ask, what is the criteria on which these various companies got these contracts? What is the background? How did you arrive at this particular group to get the projects?

Mr. MACAULEY. This goes back quite a long way, before my contact with the project.

However, the Callery people seem to be quite competent chemically. They had had experience in boron compounds on a small scale.

The Olin Mathieson Corp. had a large industrial capability, and it was felt that these two approaches to the problem were worthwhile approaches.

Mr. WOLF. Are we very limited in this country on the number of people that can do this kind of work, the number of organizations? Was there a bid made?

Did anybody bid for this? Was there a public hearing where several companies had an opportunity to get into the act and decide who

was going to get it, or did you pick these companies at random? This is the question I am interested in.

Mr. MACAULEY. I think the Navy asked a number of people, and these two were the only ones that indicated both interest and capability. I do not think that there were any other companies that had capability in the field that bid on the contract.

Mr. WOLF. What kind of reviewing board do you have that appraises the reports that these corporations send in, within your organization? Who is on it?

Mr. MACAULEY. This is the Joint Working Group.

Mr. WOLF. This is on the back page here?

Mr. MACAULEY. On the back page of the report.

Mr. WOLF. Could we, Mr. Chairman, again, have a little breakdown on these people?

The CHAIRMAN. We have had that.

Mr. WOLF. All right.

The CHAIRMAN. I do not think Mr. Macauley has given us that, but some of the other witnesses did.

Mr. WOLF. Oh, the back page they have a breakdown of the personnel there.

The CHAIRMAN. We went over that specifically.

Mr. WOLF. I do not want it at this time, Mr. Chairman, but if we could have a background on the various personnel there. Those are all my questions.

Thank you.

The CHAIRMAN. Mr. Hechler.

Mr. HECHLER. I want to ask you a friendly question:

Don't you think it would be better if this could have been researched out without the construction of this plant? I ask this, not just to play around with what has happened in the past, but as kind of a lesson for the future; would it not be better if we researched these things out a little more thoroughly without the expensive investment in the production plant.

Mr. MACAULEY. Yes, I think we did this at the urging of Project Lamplight, which was—and the——

Mr. HECHLER. Don't you think it would have been better if it had been done without production facilities?

Mr. MACAULEY. It is always less expensive, I am sure, to do it that way. At the time the urgency of the question was also taken into account and what we did was to produce plants to actually evaluate the fuels: A, to qualify a Navy engine; and B, to qualify an Air Force engine.

Mr. HECHLER. Yes.

Mr. MACAULEY. And the requirements of either of these 5-ton-a-day plants would not begin in any way to meet the needs of an operational system, let us say the B–70, or a Navy A–3–J or a full operational system.

Mr. HECHLER. Before Mr. Sisk leaves, I just want to say I think his statement this morning was a wonderful breath of fresh air. I concur 100 percent in what he said about the need for reorganization and consolidation in the Pentagon.

Mr. SISK. Thank you. I appreciate the statement of my colleague.

Mr. WOLF. If the gentleman will yield, I would like to join in this, too.

Mr. HECHLER. It seems to me the most beautiful and successfully run program in this country was in the Manhattan District under the development of the atomic bomb. I wonder if the same type of organization, spirit, and drive, could not be utilized in the missile program.

I am sorry, Mr. Macauley, did I interrupt something you were about to add?

Mr. MACAULEY. No.

Mr. HECHLER. That is all I have.

The CHAIRMAN. Mr. Daddario?

Mr. DADDARIO. You said you did get the heat value out of this boron you expected to get?

Mr. MACAULEY. Not quite, sir.

Mr. DADDARIO. Can you approximate what your original idea about it might have been?

Mr. MACAULEY. It was about 12 or 14 percent shy, wasn't it?

Mr. DONALD B. BROOKS. A little less than that shy.

Mr. DADDARIO. The reason I asked, perhaps you can clear this up for me: There was not only one decision here, but it was a double-barreled proposition, and the first shot was the cancellation of the J-93-5 because there was an agreement that engine would not be developed, and after that, you came to a decision that the boron plants would be closed down. What is the connection?

Mr. MACAULEY. The J-93-5 is an engine, an Air Force engine, a variation of the basic J-93, and is a boron-fuel burning engine insofar as the after burner is concerned.

Mr. DADDARIO. Who had the contract to produce that?

Mr. MACAULEY. General Electric.

Mr. DADDARIO. Was there any weakness in that engine? Is there a possibility here there is a combination of things that the engine did not meet the test necessary to take advantage of the heat values of the boron which you say you did develop?

Mr. MACAULEY. The afterburner combuster did not fully utilize the heat of combustion of the fuel. This is something that you always strive for, combustion efficiency at altitudes of the order of 95 percent, or thereabouts, and very frequently do not get to that extent—even with hydrocarbon fuels.

Mr. DADDARIO. Let me put it this way, then.

Was there any weakness in the J-93-5 that contributed in any manner to the cancellation or slowdown of the boron program?

Mr. MACAULEY. I know of no weaknesses, as such.

When you start to burn boron fuels in such an engine, you encounter some problems. The J-93-5 was not carried far enough along the line to say that all of these problems had been successfully met, but it was probably not carried that far because they carried it far enough to say that you still would be shy of needing the boron fuels very badly in the B-70 system.

The CHAIRMAN. Further questions?

Mr. DADDARIO. I have just two more questions.

As I understand it, there was over $8 million spent on the J-93-5 engine program alone.

Mr. MACAULEY. I do not have that figure. I can supply it for you, if you wish me to.

The CHAIRMAN. Can you put that in the record, sir?

Mr. DADDARIO. Will you get that for the record, please?

Mr. MACAULEY. Yes.

(The information requested is as follows:)

Cost of J–93–5 engine, funded by the Air Force was $8,700,000.

Mr. DADDARIO. One last question: Was there any connection at all between the decision to go ahead with this program in the first instance that might have tended to slow down the development of atomic-driven engine for aircraft?

Mr. MACAULEY. No; I cannot say that I really think this was a factor in the decisions made on any part of the ANP program.

The CHAIRMAN. Mr. King.

Mr. KING. Mr. Chairman, my mind was teeming with questions a few hours ago, but because of the lateness of the hour, I think I will pass them up. I think the ground has been covered.

The CHAIRMAN. May I ask you two questions that have been asked me to ask of you: If the Little committee recommends the closing of one of the plants, will the Pentagon be bound by that recommendation?

Mr. MACAULEY. I think that I ought to correct the record on this point.

The A. D. Little report is a report to our office. It will be reviewed by the Joint Working Group on Special Fuels, which is advisory to our office. As to their report being binding, I would say no, that the responsibility would rest with our office and with the services.

The CHAIRMAN. I have also been asked to ask you the meaning of this statement in your statement before the committee. On page 6 you say:

This office has also requested the Air Force and the Navy not to take any action which would impair the readiness of either of the 5-ton-per-day plants before October 1, 1959.

What do you mean by "impair the readiness"?

Mr. MACAULEY. Well—I believe Admiral Dixon gave testimony to this effect before you—there are three things that the Navy could do, or either service could do, with those two 5-ton-a-day plants. They could declare them surplus, and dismantle them. They could mothball them, or they could put them in standby. The Navy has taken action to put the Muskogee plant in standby until the October 1 date.

The Air Force has not taken any action that would prejudice the condition of the plant.

Now, obviously, since they are not going to be operating, their readiness is somewhat impaired, but they are actually not being "mothballed," or dismantled, and no such orders will go out prior to October 1.

The CHAIRMAN. Thank you very much.

We want to thank you for coming here.

I want to call your attention to the fact that this is not a subcommittee. Your statement gives the impression you are appearing before the subcommittee, but it is the full committee you are appearing before.

So, we want to thank you for your testimony, and since we have got to be on the floor at noon——

Mr. MILLER. Mr. Chairman, I would like to get something clear, something relevant but not directly in line with this, that was brought up. Can I ask one question?

The CHAIRMAN. If you ask a brief one. It is going to have to be brief.

Mr. MILLER. Yes; it is brief.

From time to time, the matter of whether this has interfered with the development of the atomic energy aircraft engine has been brought up. Isn't it true that the only way we know of as yet to transmit the heat generated by atomic energy into potential energy is through the matter of creating steam, and using it in a steam engine—thermonuclear?

Mr. MACAULEY. Yes. The answer is that operational there are only, so far as I know, steam powerplants.

Mr. MILLER. Steam powerplants, so one of the reasons you have not gone forward with this thing is that you were going forward with the thing pretty good while we were talking about conventional engines, but the only way we could apply the power to an airplane would be through a propeller, as we know it now—for an atomic engine?

Mr. MACAULEY. You could propel an aircraft with atomic plant through a jet engine as well. In fact, one of the powerplants under consideration for this purpose is almost certainly a jet engine, and the other is probably a jet engine.

Mr. MILLER. I wanted to get it in my own mind. I did not know they developed a jet, or the theory of the jet or the ramjet.

Mr. DADDARIO. Before you adjourn, I would suggest that the staff get somebody from the Atomic Energy Commission here as a witness to see if there is any connection, because in my opinion, there is, and I seem to have some recollection that when the moneys were expended for this program—which has come to the end that it has, that there was a slowdown in the atomic-driven engine for aircraft, and if there is a connection, we should know about it.

The CHAIRMAN. The committee stands adjourned, subject to the call of the Chair.

(Whereupon, at 12 noon the committee adjourned subject to the call of the Chair.)

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